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On Recent Vitamin Studies*

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My task is to report on the progress of laboratory work, particularly on the chemical side. Many different kinds of researchers are engaged in this field and there is great variety in outlook and training, but by dint of correlating a multitude of advances, many quite small in themselves, the whole subject is being reduced to order.

To the pure chemist a vitamin is a minor constituent in one or more natural products. He aims at:—

(*i*) Isolating it in a state of purity,

(*ii*) Unravelling its constitution,

(*iii*) Achieving a synthesis.

Such work is technically interesting because it is necessary to begin with kilogrammes, using the largest laboratory apparatus, in order to end with milligrammes of active product demanding all the resources of micromanipulation. The challenge to skill in experiment does not, however, blind chemists to the fact that the animal test is the first and last court of appeal. The recognition of a specific deficiency disease and its prevention or cure by some edible product gives the primary indication of an "X" substance worth tracking down. Diminution in the effective dose provides the basic criterion of progress in concentrating the active substance and when finally the vitamin is isolated and later synthesised, success is fully established when biological tests confirm the synthetic product as the authentic vitamin. It rarely happens that one person is competent in both the chemical and the biological field and it is difficult to over-rate the value of co-operative study.

Biological assays are, however, tedious and expensive and are not as a rule capable of high precision. Accordingly one of the main objects of vitamin research is to devise chemical or physical tests to replace the animal tests. Considerable success has already been attained in this direction.

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VITAMIN A.

This vitamin has been isolated and, it is claimed, synthesised in an impure form. It is an unsaturated alcohol $C_{20}H_{29}OH$, normally stored in the liver in greater or less amount, mainly as esters of the higher fatty acids. It does not occur in the vegetable kingdom, but the red hydrocarbon pigment carotene $C_{40}H_{56}$ acts as a vitamin precursor, the animal having the power to form vitamin A from it. Carotene is one of a large group of natural pigments (carotenoids) and occurs in all green leaves. The molecule is symmetrical and could be written as x – x (x = $C_{20}H_{28}$ –). A number of carotenoids contain one x fragment and like carotene act as provitamins (precursors). The reaction—

$$C_{40}H_{56} + 2H_2O \longrightarrow 2C_{20}H_{29}OH$$

has not been realised *in vitro* although it can occur nearly quantitatively *in vivo* since pure β-carotene (x – x) and pure vitamin A possess potency of the same order (2,000,000 International Units per gramme). Provitamins of the formula x – y where y is different from x are only about half as potent because the y half does not form vitamin. The best estimate of mammalian requirements in respect of vitamin A is 1/40 milligramme per day per kilogramme body weight. This corresponds to 1/10 c.c. average cod liver oil or about one to two teaspoonsful for each cwt. body weight.

In the normal way herbivora obtain more than ample carotene from grass and much of it is not utilised. A certain (variable) reserve of vitamin is built up and stored in the liver.

The photosynthesising vegetable plankton are rich in carotene but the zooplankton contain relatively little. The minute animal organisms of the sea feed on the phytoplankton and in turn are eaten by the fish. The food chain is obscure in respect of the precursors of the large reserves of vitamin occurring in many species of fish. The principal pigment of the minute crustaceans is astacene (the lobster pigment) and this is not supposed to be one of the A provitamins. It is evident that some

link in the argument is missing and this idea is strengthened by the fact that the halibut is some 50 to 100 times richer in vitamin A (per kilo body weight) than the cod although it eats much the same kind of food. The possibility that some species can synthesise the vitamin cannot be excluded, nor can the suggestion that the large reserves meet hitherto unrecognised needs. It has recently been shown that large quantities of vitamin occur in the alimentary tract, particularly in the ileum, duodenum and pyloric caeca of fishes. The oil from halibut intestine may contain 70 per cent. of vitamin ester and a single halibut may yield several grammes of vitamin. In striking contrast, the mammalian gut contains barely detectable quantities of vitamin, *e.g.*, less than one part per million. Possibly the processes of fat absorption are not the same, but whatever the functions of vitamin A in fish viscera it is convenient enough to know that the supplies of vitamin can easily be doubled by working up fish viscera which have hitherto been rejected.

The first symptom of vitamin A deficiency appears to be defective low-intensity vision. The retinal pigment rhodopsin or visual purple has been shown by Wald to contain vitamin A, and a complicated cycle of chemical processes involving the vitamin occurs in the normal eye. Some degree of night blindness is widespread among urban populations at the lower income levels; the condition can be detected rapidly and with some precision and usually disappears after 14 days treatment with vitamin A. There is no doubt that growth (especially in the sense of weight rather than length of bone) is retarded on a diet deficient in vitamin A, and that there is an increased susceptibility to infection. There is evidence that vitamin A assists the normal functions of mucous membranes (particularly in the eye) and that direct application promotes the healing of wounds. There is perhaps a diminished power of converting carotene to vitamin A in diabetes.

Milk is one of the very few natural products containing carotene *and* vitamin A. Spectroscopic methods enable both to be determined accurately. It is known that stall fed cows yield a winter milk much less rich in both substances than cows at grass, and the difference is reflected in the pale colour of normal winter butter. Hay, as usually made, has lost most of the carotene contained in the grass, but tests carried out on artificially dried grass show that the carotene can be conserved, and transferred to the cow with a consequent maintenance of the carotene and vitamin A content of milk at somewhere near the optimum figure. Similar experience has been recorded for maintaining quality in winter eggs.

Vitamin A_2.—A new A vitamin has recently been identified. It is closely related to carotene and vitamin A and has so far been recognised only in the eyes, viscera and liver of fishes, particularly those living in fresh water. Unlike most vitamins its existence was discovered as a result of purely chemical work and its physiological functions remain to be studied in detail.

Vitamins D.

It is not at this date necessary to recount the steps leading to the synthesis and structure of calciferol, the synthetic vitamin D made by the action of ultra-violet light on the yeast sterol ergosterol. It was once thought that ergosterol was the unique provitamin D, but at least four other substances of a similar nature can now be transformed photo-chemically into anti-rachitic materials. The resultant products can each be isolated in a state of purity and are found to vary considerably in potency although the differences in molecular structure are minute.

If the anti-rachitic potencies of a series of preparations, let us say two synthetic materials and a concentrate prepared from a fish liver oil, are determined first on rats and then on chickens, the equivalent doses are often vastly different. Thus the addition of two atoms of hydrogen to ergosterol increases by several times the efficacy of the irradiation product for the chick as compared with the rat, and a liver oil concentrate may be some 13 times as effective for chicks as a synthetic product found by rat tests to be only equally effective. This differentiation by species indicates the need for a vast programme of quite straightforward biological assays before vitamin D therapy in the animal field can be placed on a satisfactory basis for dosage. This is the more important as hypervitaminosis (although the danger is easily exaggerated) can occur more readily with anti-rachitic agents than with the other vitamins. The difficulties are also a challenge to chemists, because chemical alternatives to biological assays are far less satisfactory for the D vitamins than for A, C and some of the B vitamins.

Vitamin E.

The criterion for vitamin E deficiency is essentially resorption of the foetus. It is in this sense that the term "anti-sterility" vitamin is applicable, although there is some evidence that male and female rats fed from weaning on a diet entirely lacking in vitamin E are completely sterile. Wheat germ oil is the best known source (but cottonseed oil is also effective) and after very protracted research it seems probable that the vitamin has been isolated. It has been christened

tocopherol, its constitution is approximately known and synthesis cannot be long delayed.* It will be very interesting to see what proportion of "sterility of unknown origin" responds to vitamin E therapy. It may be quite small because sterility as a sequel to dietary deficiency is not easily brought about even under laboratory conditions. Hormonal imbalance may not respond to the administration of tocopherol on a normal diet.

The B Vitamins.

Vitamin B_1 (anti beri-beri) was isolated from rice polishings and yeast some time ago. It was christened *aneurin*, its structure determined in 1935 and a successful synthesis was reported in 1936. It can now be estimated chemically, and biologically by various tests on rats, pigeons and chicks. One of the symptoms of B_1 avitaminosis in rats is bradycardia and this can be induced in the normal animal by administering adenine nucleotides. Both the heart symptoms and a disturbed carbohydrate metabolism seem to be due to accumulations of adenylic acid. It is thus clear that the outlook is promising for elucidating the way in which vitamin B_1 functions. The pure vitamin has proved successful in the treatment of some forms of neuritis.

Another substance of importance to the B complex is lactoflavin. This is the yellow, water soluble pigment of whey, and a similar (probably identical) pigment occurs in other materials, *e.g.*, white of egg. There is certainly very little pigment in whey but enough has been obtained to characterise it thoroughly. The product can now be synthesised in quantity. The other (heat stable) components of the vitamin B complex have proved very difficult but the subject is now becoming much clearer.

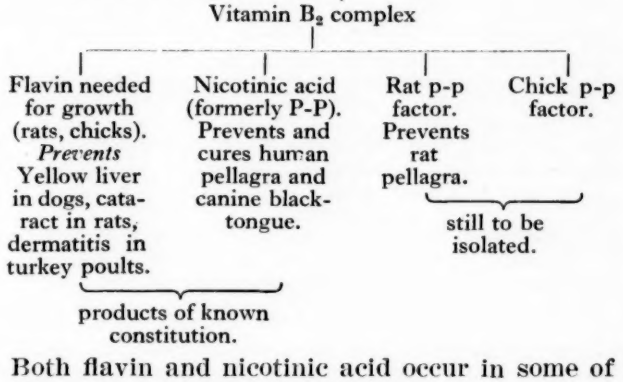
It was found in 1930 that the pellagra-preventive (P – P) action of different cereals did not run parallel to the vitamin B_2 activity measured by rat growth. Three years later the flavin was isolated in a state of purity and was said to possess "intense vitamin B_2 activity." In 1934 it was established that whilst flavin was essential for growth in the rat, it did not prevent rat pellagra or chick pellagra. The next step was to show that the rat pellagra (rat p – p) factor showed a distribution in cereals different from that of the P – P factor. In 1936 human pellagra and rat pellagra were shown to be aetiologically distinct, and it became clear that the latter required a curative agent different from that needed for chick pellagra or human pellagra.

*This has since been achieved.

In 1917 a canine deficiency disease was described and two years later the syndrome was recognised as similar to that shown in black-tongue or canine typhus. Spencer in 1916 stressed the analogy between human pellagra and black-tongue, and from 1922 onwards it became increasingly evident that in geographical distribution, dietary origin and dietary prevention the two diseases were similar. Histological studies on the lesions in dogs revealed close resemblances with the lesions of pellagra.

Late last year and early in this year it was shown that a quite simple compound—nicotinic acid—is completely effective in the cure of black-tongue and four different research units have reported the cure of pellagra in the human subject.

We thus have


Vitamin B_2 complex
Flavin needed for growth (rats, chicks). *Prevents* Yellow liver in dogs, cataract in rats, dermatitis in turkey poults.
Nicotinic acid (formerly P-P). Prevents and cures human pellagra and canine black-tongue.
Rat p-p factor. Prevents rat pellagra.
Chick p-p factor.
products of known constitution.
still to be isolated.

Both flavin and nicotinic acid occur in some of the most important enzymes.

Vitamin C.

The antiscorbutic vitamin is now available as a pure substance *ascorbic acid*. Much work has been done with the pure acid, and I think that the literature on the clinical side might well be sifted by an expert. A recent reviewer says that "much of the present day general picture suggests that liberality of intake of vitamin C may be an important factor (though not the only one) in what McCollum and Simmonds have engagingly called 'the preservation of the characteristics of youth' or in helping the body to resist the ageing process."

Perhaps this is a good note on which to terminate these remarks. The only thing I would add is that vitamin studies serve to emphasise the way in which the chemistry of the body is delicately balanced. At various points contact is made between mineral, carbohydrate, fat and protein metabolism, and vitamins are at some point connected with each, just as they are with the processes in which hormones and enzymes are concerned. Disappointments in vitamin therapy may be inevitable if the primary cause is other than defective nutrition.

	Specific deficiency effects.	Probable functions.	Occurrence.	Dose ($1\gamma = 10^{-6}$ grammes).
Vitamin A $C_{20}H_{29}OH$	Xerophthalmia, night blindness, injury to linings of body cavities.	Necessary for growth, digestion, reproduction, lactation, increasing resistance to respiratory and urinary infections.	Liver fats, particularly cod and halibut liver oils, fish viscera, milk.	20-30γ per day per kilo. body weight.
A_2 ?	?	?	Fish oils, especially fresh water fish.	
Carotene $C_{40}H_{56}$ (fat soluble).	Typical of a group of carotenoid provitamins A. Carotene is converted into vitamin A in the animal but may have valuable properties distinct from those of the vitamin.		Green leaves and fodder, dried grass, carrots, red palm oil.	20-30 γ or 30-50 I.U.
Vitamins D (several) all sterol derivatives (fat soluble).	Rickets, osteomalacia, leg weakness in chicks.	Regulates mineral metabolism, promotes healthy teeth and bones. Prevents rickets; connected with thyroid and parathyroid function.	Fish liver oils, synthetic products made by exposure of sterols to ultra-violet light. In skin after exposure to sunlight.	Minute but variable
Vitamin E $C_{29}H_{50}O_2$ tocopherol (fat soluble).	Death of foetus and resorption. Sterility due to degeneration of germinal epithelium.	Necessary for normal male and female reproductive processes.	Wheat germ (oil), lettuce, watercress, and to a less extent whole cereals, peas and beans. Cottonseed oil.	Unknown with certainty, but relatively large. (Milligrammes.)
Vitamin B_1 $C_{12}H_{18}N_4OSCl_2$ (water soluble)	Beri-beri, polyneuritis, cardiac weakness, poor appetite, retarded growth, impaired resistance.	Stimulates metabolism, growth, etc. Necessary for maintaining healthy nervous system.	Yeast. Whole cereals (especially germ). Synthetic product available. Cottonseed meal, soya beans, ground nuts.	5-10 I.U. per day per kg. body weight.
Flavin (riboflavin) $C_{17}H_{20}N_4O_6$	Retarded growth *in rats*. Dermatitis, loss of hair.	Necessary for normal growth.	Yeast, whey, soya beans, eggs. (Wheat germ, cottonseed meal less good.)	Uncertain.
Ascorbic acid (Vitamin C) $C_6H_8O_6$	Scurvy, muscular weakness—fragile bones, loose teeth.	Needed for oxidation processes inside cells.	Orange or lemon juice, red or green peppers, many vegetables and fruits.	6-10 I.U. per day per kg. body weight. (Some species do not seem to need dietary ascorbic acid.)
Nicotinic acid $C_6H_5NO_2$	Pellagra, black-tongue.	?	Liver, lean meat, ground nut meal, wheat germ.	?

Discussion

Professor J. F. Craig said that the President had informed them that Dr. Morton had told them all he knew about vitamins and their effects on animals but with that view Professor Craig said he would not like to concur. Dr. Morton was a well-known authority on the subject, to which he had devoted many years of study, and it was physically impossible for him to have covered the whole ground in the time at his disposal.

At one time it was considered that the important constituents of food stuffs were confined to carhydrates, fats, proteins, salts and roughage but that idea had been radically altered in recent years by the enormous amount of research work that had gone to show that there were other accessory substances required for life and growth, although present only in minute quantities—substances which exerted a powerful influence in the proper adaptation of the food constituents for the activities of different organs and tissues of the body in the production of energy. At the present time one was perplexed and even confused by the great varieties of these accessory substances, or vitamins, which had been determined by exact experiment in various animals. Their effects, if not their method of action, had been elucidated in a variety of animal species.

When one came to estimate the importance of vitamins and vitamin deficiency in animal diseases, one felt that it was not easy to make an assessment because of the great variations in the nature and the quality of the diet and in the environment of animals.

It was known, *e.g.*, that vitamin C was synthesised normally in the tissue of rats, pigs, cattle

and fowls and vitamin B complex in cattle was manufactured by bacteria in the rumen contents, while vitamin D was produced by irradiation from the sun's rays of sterols in the skin and vitamin A was supplied in the green colouring matter of the food in form of its precursors carotene or carotene compounds.

It thus happened that under natural conditions the affections attributable to want of vitamins were seldom of a pure type and were accompanied by other variations in the diet or environment which materially affected the production of disease. The lack of certain vitamin or vitamins often probably represented one link of the chain relating to the production of a particular affection. At any rate it was almost impossible at times to exclude a number of factors other than vitamins.

One had of course cognisance of various animals' diseases in which vitamin deficiency played a part.

As regards deficiency in vitamin A, one might say that the affections implicated were often related to intensive rearing and artificial diets. They included pasty eyes in ducklings—which was attributed to defective feeding of the dams—nutritional roup in chickens on a diet of white maize, and some cases of gout in chickens, and nervous disorders in pigs. Some forms of sterility in cows had been attributed to deficiency in vitamin A, *e.g.*, this was the view taken by Hard, McCallum and Steenbock in a herd fed on bleached Timothy hay and in the cases there described oestrus was absent.

It was known that want of vitamin A caused degenerative changes and keratinisation of epithelium and there was evidence that a deficiency in this vitamin might lead to increased susceptibility to catarrhs of various mucous membranes. On the other hand, there was no definite evidence that want of vitamin A rendered an animal more susceptible to various specific contagious diseases.

Vitamin D was largely bound up with skeletal development and bone changes, and particularly rickets. Even there vitamin D was not the only factor and in pigs perhaps deficiency in calcium was often more important than deficiency in vitamin A.

In big head or osteodystrophia fibrosa in horses, the bone changes were attributed in warm countries to an imbalance of calcium and phosphorus in the food, but it had been suggested that in those cases which occasionally appeared in the temperate climates such as ours deficiency in vitamin D might play a part.

The same condition in goats was seen when the animals were kept in confinement in the cities.

Vitamin E was shown to have an important bearing on fertility and there was some evidence that deficiency in this vitamin was under certain circumstances related to the production of sterility in animals. It was, however, a matter of speculation in determining what factors were responsible when no anatomical changes could be found. Want of vitamin E did not interfere with the oestral cycle and in that respect was different from deficiency in vitamin A.

One would like to be able to ascertain in any given suspected case (1) whether the body of the animal was depleted of a particular vitamin: it was known that some of the vitamins could be stored for a time and a test for their presence in the living animal would be of great value; and (2) what would be an efficient and sufficient dose if the vitamin was to be used in concentrated form. It was of course known that vitamin D if given in excessive quantities gave rise to widespread deposition of calcium in the walls of arteries, heart muscle, kidneys, etc. This was perhaps the only instance in which serious trouble might arise, yet an inefficient dose might not be followed by expected beneficial effects.

In conclusion he thought that he had said enough to open the discussion upon the very excellent address which Dr. Morton had given them and he would like to congratulate the Association upon having been able to prevail upon Dr. Morton to speak to them upon a subject which was of so much interest.

Mr. W. Woods prefaced his contribution to the discussion by stating that he had been intensely interested in what he had heard with regard to the effects of vitamins upon animals. He had studied vitamins and thought he knew something about them, but after hearing what Dr. Morton had told them he had come to the conclusion that he knew very little about vitamins. He would like to know whether there was a synthetic B vitamin suitable for cases of canine black-tongue which Dr. Morton seemed to connect with the Eastern disease pellagra. If so, it would be a very useful thing for a practitioner if he could go to a druggist and get some of this particular vitamin and cure black-tongue in the miraculous manner which Dr. Morton had mentioned, because it did seem to have an extraordinary effect upon that affection.

It was not too common in dogs, but still one met with it from time to time, and he would like to know if Dr. Morton was able to tell them whether there was any food which was comparatively rich in vitamin B or vitamin B_2. One food which was advertised was "Bemax," which was supposed to be very rich in vitamin B. Could Dr. Morton tell them whether "Bemax" was a useful food to recommend? They knew nothing about the makers, but at any rate he believed it was an "honest" material made from wheat germ and not a quack preparation at all. It would be very useful, he considered, if Dr. Morton could give them some information on the matter.

Sir Frederick Gowland Hopkins had been the first Englishman to go into the question of vitamins, and he (the speaker) had greatly

enjoyed following the whole of his experiments, particularly on rats. Dr. Hopkins' patience in connection with those experiments, and the knowledge he had gained, constituted to his (the speaker's) mind a most marvellous achievement. He had met the doctor at a dinner, and on that occasion had hoped to have a word with him, but that hope was only very partially realised. He thought Dr. Hopkins deserved the credit in this country at any rate, for having gone so thoroughly into the question, and for having placed his knowledge at the disposal of veterinary practitioners.

Personally, he had come to the conclusion that he (the speaker) knew very little about vitamins, having regard to the fact that so much had been discovered about them since he had gained his knowledge. At that time he thought he had learnt all there was to know about them, but so many had been discovered since that time that he would like Dr. Morton to come again and give them a second lecture upon the subject. It had certainly been most interesting. Personally, he thanked Dr. Morton very much indeed for what he had told them, and he was sure that all who had listened to the address were of the same feeling. (Applause.)

Mr. G. C. Webster, expressed his appreciation of the address and referring to the question of vitamin deficiencies, stated that this was a very serious matter with humans in some countries and we were beginning to appreciate the value of vitamin treatment with animals in this country. Many obscure cases in canines and bovines had responded in a surprisingly satisfactory way to this treatment. A closer co-operation by veterinary practitioners and organic chemists would, he felt sure, give as satisfactory results as we had obtained from co-operation with biochemists.

Dr. Morton's address had certainly helped him to realise how very much further they had still got to advance, not only in the matter of diagnosis but also in the application of vitamins, before they could attain to anything like 100 per cent. efficiency.

Mr. C. F. Shawcross observed that he had been very pleased to have had an opportunity of listening to Dr. Morton's address, but he was afraid he could not add much to the discussion. With regard to the affections which one might expect from a deficiency of vitamin A, Dr. Morton had not mentioned the symptoms found in rats. It was also possible, no doubt, to get a deficiency of vitamin A in dogs getting an entirely biscuit diet, and when a veterinary practitioner was called in how could he recognise a deficiency of vitamin A? With regard to cattle, in the winter time they were fed on hay, cake and other dry material, but apparently they could not get vitamin A except from the grass in summer and must therefore often suffer from a deficiency of vitamin A before spring.

With regard to the symptoms that might result from vitamin B deficiency, a few years previously he had been experimenting with a preparation made from wheat, and he had a cockerel brought to him which showed nerve symptoms. He prescribed some of the wheaten preparation and very much to his surprise in a few days the cockerel was comparatively all right. A week or two later a rabbit which was paralysed in the hind legs and which looked like dying was brought to him. The same treatment was tried, and the rabbit also made a very wonderful recovery. He would like to ask Dr. Morton what were the particular symptoms of vitamin A deficiency which he could point out to them, apart from night blindness, which it would be difficult to recognise in animals. He would also like to add his tribute to Dr. Morton for what had been a really interesting paper.

The President (Mr. G. Mayall) adding his quota to the discussion, remarked that in the middle ages there had been much striving with a view to discovering the elixir vitae, but it only got as far as a good deal of faith in tincture of aloes. If some of the philosophers had lived to-day they would have delighted in the discovery and uses of the vitamins.

The vitamin content of milk was important in the rearing of children, and for growth, health and reproduction; and the butter fat in it was the chief source of vitamin A. It was said that the Guernsey cow came first in this respect, followed by the Friesian, Ayrshire and Shorthorn. Pasturage increased the vitamin A content of milk. Vitamin C content, the absence of which caused scurvy, seemed only to be influenced by the stage of lactation, and was highest during the early stages of lactation.

The vitamin D content of milk was higher in summer than in winter, and its presence in milk assisted bone formation, and was probably aided by both the pasture and the sun. Most of them knew the importance of vitamin D in the feeding of chicks. He had seen wonderful results obtained from the careful use of a good spoonful of cod liver oil where chicks had been floundering about, and were right off their legs. The uses of the various vitamins in connection with poultry made a very interesting study.

He had been very pleased to hear about the black-tongue remedy. In his experience he had seen only one case which he should call black-tongue and then the tongue was a marked bluish-black. It was interesting to know that there was a remedy for it, and he thought veterinary surgeons would be glad to know where nicotinic acid could be obtained, and how it ran out in price, because they were called upon to treat a good many cases of canine typhus.

With regard to vitamin B, they might be interested to know that he had been taking some himself and that it had cured his sciatica, and also a certain amount of breathlessness. (Laughter.)

Mr. H. R. Hewetson said that Dr. Morton's remarks certainly formed one of the most interesting and informative talks he had heard for some time. He felt that the time of the members would be more profitably spent listening to more of Dr. Morton—who said he had cut his remarks short on account of time—than in listening to what he (Mr. Hewetson) had to say. (Laughter.) What he had heard made him desirous of obtaining more knowledge on the subject of vitamins, and he hoped that Dr. Morton in his reply would certainly go a little bit deeper into the question of vitamin C, for instance, and tell them something of "some of the other letters of the alphabet" which as yet they had heard nothing about from him.

Of course, they had possessed some vague views of what vitamins did, and what resulted from deficiencies, up to a point, but they could now see what a complex problem arose from the interaction of vitamins and some of the

chemical elements. Professor Craig had dealt with the effects of vitamins on sterility as applied to cattle. He was also concerned with the sterility met with in small animals and so far he had had no success with vitamins in connection with them.

They were all familiar with certain obscure lamenesses in horses and the development of osteo-arthritic conditions. Professor Mitchell had comprehensively covered most of these conditions under the term "rheumatic disease" and D. M. Campbell, in certain observations in American army horses in the Philippines, had dealt with them as part and parcel of a deficiency disease. Both these gentlemen referred to calcium shortage, and whilst it was generally accepted that the majority of forage fed to horses contained an overwhelming excess of phosphorus in relation to calcium, thereby resulting in heavy calcium loss, it would appear that these balances could be materially affected by the available supply of vitamin D, and he would be interested to hear Dr. Morton's views on this.

Certainly one saw cases of intermittent lameness in horses, particularly in horses which were prone to suffer from such attacks of lameness in the winter time, but which attacks cleared up in summer when they had a proportion of time at pasture. He had had cases where, with the administration in the winter time of artificial dried grass, bone meal and cod liver oil, the lameness had been overcome.

With regard to canine black tongue, he thought that the disease occurring in America was not, as described, strictly comparable to similar conditions occurring in this country. The so-called Stuttgart disease and the necrotic and ulcerative stomatitis associated with nephritis which we saw in this country, were in his opinion different conditions altogether from what the Americans described as black-tongue, and the vitamin B_2 deficiency underlying it.

With regard to Professor Craig's references to the toxic dose of vitamin D, and to the results which they might expect from it, Dr. Morton had also told them that there were some vitamins which had toxic effects, and he (the speaker) would be very glad if Dr. Morton would inform them what other vitamins could have toxic effects. He would also like to know if, for example, they could give vitamin A in sufficient excess to increase resistance beyond the normal, or, on the contrary, would any excess simply be dissipated and lost. In conclusion, he desired that Dr. Morton should feel how really interesting his address had been, and he (the speaker) hoped, for one, that they would hear more from him later on in the afternoon. (Applause.)

The Reply

In his reply, Dr. Morton expressed his thanks for the kind way in which his remarks had been received. The methods of standardising vitamin preparations were in the hands of the Health Organisation of the League of Nations and all the principal firms marketing such products endeavoured to specify the potency of their preparations in terms of units accepted internationally. The vast majority of manufacturers claimed no more than could be substantiated.

Answers to some of the other queries had been incorporated in the paper.

"Warfa" ("Swayback") in Lambs in North Derbyshire and its Prevention by adding Copper Supplements to the Diet of the Ewes during Gestation*

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This communication deals with a disease amongst lambs in North Derbyshire known locally by the farmers as "warfa." It presents information, obtained from a field survey, on the nature and extent of the disorder, which is shown to be similar to "swayback" as described by Innes.[1] A description is given of a large scale experiment conducted in the district last winter (1937-38) on some 50 farms. The results of this experiment show that "warfa," or "swayback," is caused by a nutritional deficiency of copper and may be prevented by providing the ewes during gestation with mineral licks containing that element.

*The Editorial Committee of the *Veterinary Record* has suggested that we add a foot-note so "that it may be made quite clear what was the work that had previously been done and the measure of your indebtedness to it in pursuing your own experiments."

With regard to the first point, we feel that we are not sufficiently conversant with the literature on "swayback" to review work previously done. The library attached to this Institute subscribes to a limited number of journals and only two of these are devoted to veterinary subjects. We consider, therefore, that one of the Australian workers, Dr. Innes, or some institute extensively equipped is better qualified to give an accurate account of previous work.

With regard to our indebtedness, we wish to acknowledge the encouragement which we received from Dr. Hedley Marston. We had frequent discussions on "swayback" when he visited England in 1937-38. He convinced us, as much as did our survey, that lead was not the primary aetiological factor in the disease. He also approved of our proposed experiment with the trace minerals. With his wide knowledge of field experimentation, our experiment would probably have been better planned than it was had he found time to visit the district and advise us.

The first intimation which we received that Cu was definitely the aetiological factor in "swayback" consisted of the abstract of Bennetts and Chapman's paper appearing in *Nutrition Abstracts and Reviews* this year. The paper abstracted appeared in the August, 1937, issue of the *Australian Veterinary Journal*. We have just read the text of this most excellent piece of research. As far as we know, these workers were the first to show the relationship between swayback and Cu deficiency and must be given full credit for the discovery.—G.D., August 31st, 1938.

Our attention was first directed to the seriousness of "swayback" in North Derbyshire at a meeting of sheep-farmers held at Bradwell in January, 1937. The occasion was a lecture on Sheep Diseases delivered by one of us (G.D.). The disease had been referred to only cursorily during the course of the address but in the discussion which followed it was the sole topic of interest. On offering what help we could in solving the problem, the farmers present readily accepted with promises of providing us with complete details of their experiences of the disease on their farms as well as assistance and animals for experimental purposes. The investigation was commenced in the following March.

Symptoms.—In North Derbyshire the disease is confined almost exclusively to lambs during the first month of life. Most are affected at birth and are unable to raise themselves to obtain milk from their dams. Others can struggle to their feet but sway about in a peculiar manner and collapse or turn somersaults if they attempt to walk. A few become affected at later stages and the symptoms may only be noticed when the young animal is disturbed. Before it has proceeded far the hind quarters are seen to sway as if paralysed and it falls over on its side practically helpless. The mortality rate of affected animals is almost 100 per cent. Slight symptoms may be noticed in one ewe out of every thousand examined.

The Affected Area. — The affected farms, about 100 in all, comprise an area of 38 square miles or 25,000 acres with the village of Bradwell as the centre (Fig. 1). The boundary of the area extends roughly eastwards in a straight line from Ringing Roger in Edale to Hathersage, and from there directly southwards to Stony Middleton. From this township the southern limit is marked by the road to Buxton as far as Sparrowpit, while on the west a straight line from Sparrowpit to Edale cuts off the affected from non-affected farms fairly well. Within this rectangle the disease occurs or has occurred on practically every farm and increases in severity as the centre of the area is reached. On the worst farms the ewes are sent away for wintering to Cheshire or Yorkshire from early November until April, otherwise 50 to 80 per cent. of the lambs are lost. A few farms lie practically derelict on account of the trouble.

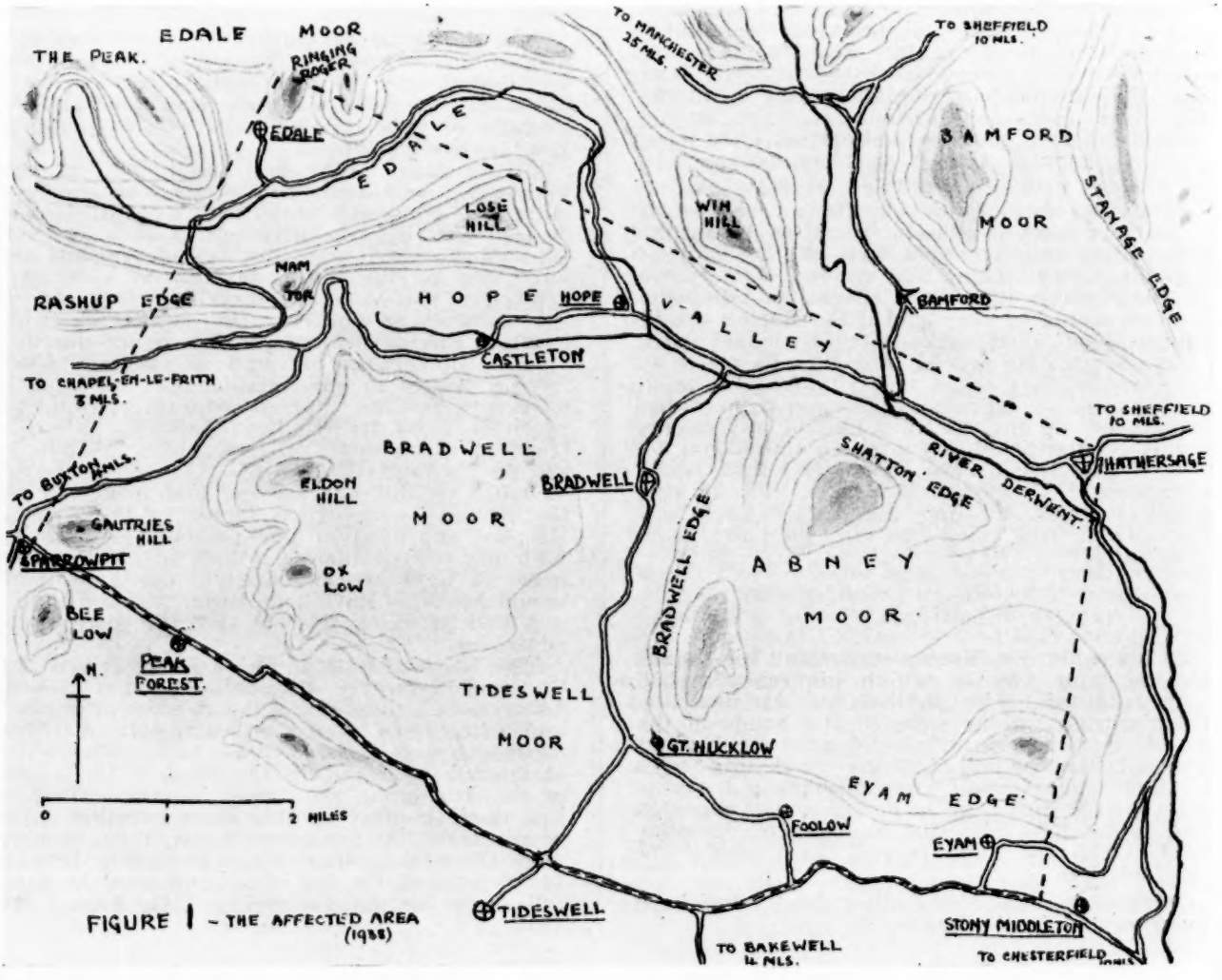

FIGURE 1 – THE AFFECTED AREA (1938)

I. FIELD SURVEY

Upwards of 200 farms within and without the district were visited in the spring and summer of 1937. Complete information of the occurrence of the disease, seasonal and breed incidence, severity and the year in which it first appeared was obtained from each farmer. Their observations on a number of factors which, we considered, influenced the above data were also obtained. Finally we asked them to state their theory of the aetiology.

Summary of Results of Survey.—(The complete details have been published elsewhere by one of us (H.E.W.)[5]). They are summarised here and brought up to date to include more recent data). The disease has been known in the district within living memory and also apparently within the memory of deceased parents and grand-parents of the present farmers. It was established definitely that "warfa" has existed in Derbyshire for at least 120 years and probably longer than that. One other interesting fact emerged. Until a few years ago the disease had only occurred on some 30 farms. During the past five or six years the trouble has become more widespread and the area affected has now enlarged to cover almost 100 farms with a total area of 25,000 acres. The reason for this recent spread we hope to discuss in a later paper.

Geological Formation. — The disease occurs on soils overlying limestone, gritstone and limestone shale formations.

General Incidence.—Figures for the incidence of the disease on the various farms will be found in Table I and Appendix. It is by far the most serious disease affecting sheep in the area. On the worst farms within a mile of Bradwell 70 to 90 per cent. of the lambs are affected and die. Another smaller area with the same incidence lies two miles to the south of Bradwell.

Breed Incidence.—The disease affects all breeds of sheep in the district. We were unable to obtain any evidence that certain breeds are more subject to the disease than others. Some flock owners, however, were of the opinion that it was more prevalent in polled breeds than in horned. The following are the common breeds and crosses kept in the district.

Pure Breeds—Blackface, Swaledale, Gritstone, Masham, Baumshire and Suffolk.

Crosses—The above breeds crossed with Oxford, Suffolk, Hampshire and Border Leicester tups.

Age Incidence. — The disease affects lambs from ewes of any age: it appears just as frequently from first and second crop ewes as from older ones. Furthermore, it does not follow that once a ewe has produced "swayback" lambs she will always do so. A typical example of this is the case of one farmer who retained for a second season eleven gimmers that had all produced "swayback" lambs and not one "swayback" lamb was obtained from them in the second crop.

Hereditary Influences. — Our investigation showed conclusively that the disease is not hereditary. Besides a number of similar cases which were described to us we saw for ourselves two slightly affected ewes, which the farmer has successfully reared and bred, nursing perfectly normal and healthy lambs. Either sex or both of twin lambs may be affected with the disease. A number of cases were also observed in which a ewe had produced twins: one lamb so badly affected that it was unable to stand whilst the other showed no visible symptoms and appeared perfectly healthy.

Post-mortem Examinations.—A number of affected specimens were submitted to Dr. J. R. M. Innes at the Animal Pathology Institute, Cambridge, for examination. The lesions observed were found to be exactly similar to those of swayback as described by Innes elsewhere.[1] The symptoms that we have described (page 1176) for "warfa" are also those of "swayback." It appears therefore that "warfa" and "swayback" are one and the same disease.

General Conclusions. — Innes[1] has already ruled out the possibility of any infectious agent being responsible for this disease. The information collected in the survey also provided little evidence that the disease was of an infectious nature. On the other hand, the following facts indicated that the disease was connected with some dietary factor:—

(1) Its incidence varies from season to season, depending on the amount of winter and spring herbage consumed by the ewes.

(2) If large amounts of concentrates have to be fed to the ewes during the winter as a result of snow and hard frosts the incidence of the disease amongst the lambs is greatly reduced.

(3) On slightly affected farms the disease can be avoided by changing the ewe flock each year. Badly affected farms also adopt this practice to reduce the disease incidence.

(4) Ewes which have produced affected lambs give birth to normal lambs the following season when drafted out of the district. (On badly affected farms the ewes are wintered from November until lambing time in Cheshire and Yorkshire and few cases of "warfa" arise.)

(5) It is endemic and shows no tendency to spread to ewes outside the district.

Aetiology.—A number of farmers interviewed were strongly of the opinion that the disease was the result of lead poisoning. Almost as many, however, were convinced that lead played no part in the aetiology. Innes also had failed to produce the disease by feeding excessive amounts of lead to the ewes. While the district is traversed by many lead rakes and "belland" or lead poisoning is met with in other farm animals, especially horses, there are a number of affected farms on which there are no lead outcrops whatever. The working hypothesis, which we formed as a result of our investigations, postulated that the disease was the result of some dietary deficiency, most probably mineral in nature, and that lead might play a part by interfering with the normal metabolism of the element, either in the lumen of the intestine or after absorption.

There was some evidence available from the survey that a number of mineral elements could be ruled out as possible factors in the cause of the disease. Extra mineral feeding was practised on some of the affected farms either in the form of additions of salt and limestone to the concentrates or as proprietary mineral licks placed in the hay racks. The disease, however, persisted in spite of these additions. On approaching the makers of the various licks we were informed that they contained appreciable amounts of the following elements: Ca, Fe, Mg, Na, K, S, P, Cl, and I. It appeared therefore that, if a mineral deficiency was involved, attention should be directed first to the trace elements. Marston[2] had already shown that one of these—cobalt—is indispensable for the proper nutrition of sheep.

As to which of the trace elements should first be investigated, we had some evidence in the district that the deficiency of two caused disease in plants. Experiments had been conducted for some time on farms in the vicinity on the occurrence of leaf stripe in oats which is the result of a deficiency of manganese. Another disease is met with in the root crops on some farms. Swedes are frequently attacked with "brown heart" which has been shown to be due to a deficiency of boron.

With regard to the animals themselves we had noticed that the blood of the ewes was frequently anaemic. While a marked anaemia of ewes is common on moor and hill farms in Britain it is rare amongst flocks on arable land and a number of the affected farms were low lying and produced excellent crops of cereals and roots. As possible factors in this anaemia we decided that the minerals Fe, Cu, Co and Mn might play a part. Furthermore, Dr. Hedley Marston in a private communication informed us that his colleagues in Australia considered enzoötic ataxia—a similar disease to "swayback"—to be associated with Cu deficiency.

II. EXPERIMENTAL PROCEDURE

A number of farmers were interviewed with regard to the feasibility of conducting feeding experiments on their farms and their views were invited on the best methods of feeding minerals to sheep and planning the experiments. From their observations it was soon evident that to impose five treatments on single farms, which was the ideal plan for the experiment, would be impossible. The stone walls between farms are in a moderately stock-proof condition but between fields on the same farm they function more as shelters than as barriers for stock. There were also other practical difficulties against this method. We were therefore forced to adopt the less accurate but more convenient method of alloting one treatment to one farm and including as many animals and farms as possible in the experiment.

To be reasonably certain that every sheep on experiment will consume a certain proportion of the minerals the most satisfactory method, apart from drenching, is the incorporation of the elements in a palatable concentrate mixture. The survey had shown, however, that supplementary concentrates were fed to the ewes for only about one month previous to lambing and it was unlikely that we could persuade all farmers to commence the extra feeding some four months earlier or just after tupping. We therefore decided to feed the minerals as licks which could be placed under shelters in the fields for the ewes to consume as they pleased. In this case we had to sacrifice accuracy in dosage to be certain that the minerals would be ingested over a sufficiently long period of time to produce results. The lick method, involving as it does less labour and expense, was considered to be the most satisfactory under the circumstances.

The co-operation of 36 of the most reliable farmers was invited and 33 agreed to co-operate in the experiment. The method of allocating the licks to the various farms was as follows. Firstly they were arranged in descending order from heavily affected to practically free. After being grouped off in fours the names in each quartet were withdrawn from a hat and assigned to one of four separate groups. The mineral mixture to be fed to each group was determined in a similar fashion.

The essential differential characteristics of the mineral mixtures were as follows:—

Mixture.	*Trace minerals present.*	*Per cent. in mixture.*
W	Co, Cu, Mn, B.*	0·3 of each
X	Co alone	0·3
Y	Cu ,,	0·3
Z	Mn ,,	0·3

* Licks containing boron alone were not manufactured. The farms on which they should have been fed have been added to Group E in the experiment.

Table I.

Summary of Results—Warfa Experiment, 1937-38.

Group.	Mineral mixture.	No. of farms.	Total No. of ewes.	Lambs born.	"Warfa" cases— Expected.	Actual.	Other deaths.	Per cent. lambs infected.
A (Pos. controls)	W	7	307	355	40·1	**7**	32	**1·97**
B	X	8	272	365	24·3	**38**	24	**10·3**
C	Y	9	388	513	35·0	**9**	43	**1·75**
D	Z	9	300	423	43·8	**66**	32	**15·6**
E (Neg. controls)	None	18	539	741	—	**113**	50	**15·2**
Whole district	—	83	3,317	4,369	—	**336**	385	**7·83**

These trace elements were added in the amounts indicated to a basal mineral mixture consisting of commercial common salt and made up into licks of 5 lb. each in weight.

Four flocks—one in each group—received the minerals in powder form to be added to the cencentrates which were to be fed throughout the winter on these farms. The allocation was on the basis of 1½ lb. of the minerals per ewe for the period of gestation. On this basis each ewe was allowed 10 mg. of the trace elements per day.

There was some delay in the manufacture of the licks which were to have been ready by the first week in November. Actually they were not distributed till the beginning of December or about a month after a few of the ewes on the early lambing farms had been put to the tup. Generally, however, they took to the licks fairly well and by the New Year the great majority had become accustomed to them and the consumption was quite appreciable. In one or two cases observant farmers noted that an occasional ewe never came near the troughs in which the licks were placed; but this was exceptional.

Results. — The open climate of the early months of the year made likely a high incidence of "warfa" amongst the lambs. The farms were visited every month and observations recorded on the condition of the ewes, any changes in the diet and the rate of consumption of the licks. While it was found necessary to supply two farms with extra minerals the number allocated to each farm was generally sufficient. Ninety-two per cent. of the minerals distributed were consumed by the ewes in the experiment.

The final observations were taken during the last week of May. The results have been summarised in Table I and are given in full in the Appendix.

In the "warfa" columns the figures under the heading "Expected" are the average number of cases per year for the three seasons 1935-37. The number of lambs which actually showed the disease this year under the experimental conditions is given in the next column under "Actual." The low expected figure for group B is accounted for by two farmers, who had been badly hit with the disease in 1937, deciding to send away half of their ewes (60 in all) for wintering shortly after the experiment commenced. Had these ewes been retained on the farms the expected figure would have been 35·1 and the actual figure correspondingly higher. The data required to compute the expected figure for all the control farms has been difficult to collect and no accurate estimate is available. The column headed "Other deaths" lists fatalities from joint-ill and "wool ball" as well as cases of still-born lambs.

Group E — negative controls — consists of infected farms adjoining the experimental farms. The flocks on these farms did not receive any of the experimental treatments.

We have also included the figures for the whole of the affected area. This last group—"whole district"—includes the experimental groups, the negative controls, farms on the fringe of the district where the disease is sporadic as well as the flocks drafted out of district for wintering. The ewe population of the area in May is almost twice the number retained during the winter months and consequently the figures in this group give no *real* indication of the incidence of the disease in the district.

Discussion of Results. — Reference to the composition of the mineral mixture fed to the groups (page 1178) shows that (1) the complete mixture of trace minerals and (2) copper alone, were both instrumental in reducing markedly the incidence of "warfa" in the offspring of the ewes. The feeding of cobalt or manganese has no apparent effect. If the groups receiving copper are grouped together and compared with (1) flocks receiving minerals but no copper and (2) flocks receiving no minerals whatever—the negative controls—the following are the results:—

Group.	Farms.	Ewes.	Lambs.	Per cent. affected.
Minerals plus copper	16	695	868	1·84
Minerals, no copper	17	567	793	13·2
No minerals ...	18	539	741	15·2

The addition of copper supplements to the diet of the ewes appears to be the factor responsible for the reduced incidence of "warfa" amongst the offspring.

Reference to the Appendix will show that only in the case of three of the 51 farms are the results inconsistent. Two of these are in group B and both of these flocks received the minerals mixed with concentrates throughout the gestation period. It is possible that there was sufficient copper in the concentrates to supply the ewes with all they required but there is evidence that other factors also were involved. In the case of farm B3 the farmer received the minerals as licks. He placed these in a sack and reduced them to powder form with a hammer, before adding them to a mixture of one part flaked maize plus two parts of proprietary sheep cakettes. The sack was found to be one which had contained seed oats, treated with copper sulphate powder to avoid fungoid diseases at germination. The ewes themselves had suffered severely from foot-rot during the winter and the diseased trotters had been treated liberally with copper sulphate paste. In the case of farm B7, which was the farm in this group to receive the minerals in the powder form, concentrates were fed in liberal amounts throughout the winter and foot-rot dressings of blue vitriol were again a complicating factor. Ten of the 17 ewes were newcomers to the district in October.

The remaining farm — A2 — receiving the complete mixture, had changed tenants repeatedly for some years and was practically derelict. The figure given for "expected" cases is, we believe, based on unreliable data. The stocking was at the rate of one ewe to four acres and the minerals were consumed only in small amounts. Furthermore, since it was the first farm to commence lambing, the ewes received the treatments for a shorter period of time than any other farm in the experiment.

The results on the remaining 48 farms are consistent with the general effect of the treatment imposed.

A recent publication from Marston *et al.*[3] states that they have been able to confirm the association of copper deficiency with enzoötic ataxia in lambs (which appears to be the same disease as "warfa" or "swayback"). It also appears from their paper from Bennetts and Chapman[4], as a result of drenching experiments, were the first workers to show conclusively that the disease could be prevented by the administration of solutions of copper salts to the ewes. The Australian work and our own can leave no doubt that "warfa," "swayback" or enzoötic ataxia is caused by a nutritive deficiency of the trace element, copper.

The lick method which we have adopted has given complete satisfaction to the farmers in Groups A and C as a preventive for the disease. The licks are placed in convenient shelters in the fields and left for the ewes to consume at will. A little teasing is perhaps necessary in a few cases and some sheep concentrates may have to be spread over the licks for a day or so to accustom the sheep to them.

We intend continuing with this method of copper administration in our experiments during the coming winter. Further information is required to determine the stage of gestation over which they *must* be fed to prevent symptoms in the lambs. While the amount of copper added to the experimental licks appears sufficient in amount to control the disease in this area it would also appear advisable to determine the maximum amount which can be included before symptoms of copper poisoning appear in the ewes and also the lower limit at which insufficient amounts lead to "warfa" symptoms in the lambs.

Summary and Conclusions

"Warfa" or "swayback" affects lambs in a severe form in North Derbyshire. The limits and the extent of the affected area are described. The affected farms number about 100 and cover 38 square miles or 25,000 acres.

The results of a field survey of the disease as it occurs in the district are given.

A large scale field experiment was conducted on 1,800 ewes on 51 farms to determine if the disease could be prevented by feeding certain trace elements to the ewes during gestation. These elements were Co, Cu, Mn, and B. They were included at the 0·3 per cent. level in special mineral licks. Each ewe was allowed 1½ lb. of minerals for the period of gestation or 10 mg. per day of the trace elements.

The results showed that the incidence of the disease was greatly reduced amongst the offspring of ewes receiving the licks with copper supplements. Cobalt and manganese had no effect.

"Warfa" or "swayback" can be controlled by feeding licks containing 0·3 per cent. Cu to the ewes during the gestation period.

Acknowledgment.—We wish to express our indebtedness to Messrs. Boots, who supplied the licks free of charge and assisted in their distribution.

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[4]Bennetts, H. W., and Chapman, F. E. (1938.) Copper deficiency in sheep in Western Australia: a preliminary account of the aetiology of enzootic ataxia of lambs and an anaemia of ewes. Abst. in *Nutrn. Abs. & Revs.* **7,** 794.

[5]Wells, H. E. (1937). "Swayback" in Lambs. *Derbyshire Farmer.* **17,** 280.

APPENDIX
Detailed Results of Experiment

Group A.

Treatment—1½ lb. minerals containing 0·3 per cent. Co, Cu, Mn, B per ewe during gestation: positive controls.

Farm No.	No. of ewes.	Lambs born.	Warfa cases— Expected.	Actual.	Minerals fed from.	Lambing commenced.	Per cent. licks consumed.
1.	104	105	2·9	0	Dec. 14	Mar. 29	100
2.	21	35	1·1	6*	„ 18	„ 7	75
3.	18	26	5·9	0	„ 16	Feb. 16	100
4.	57	51	18·2	0	„ 10	Mar. 15	100
5.	50	63	3·3	1	„ 20	„ 26	70
6.	14	16	8·0	0	„ 10	Apr. 10	50
7.	43	59	0·7	0	„ 17	Mar. 30	100
7.	**307**	**355**	**40·1**	**7**	—	—	—

* See text (p. 1180).

Group B.

Treatment—1½ lb. minerals containing 0·3 per cent. Co per ewe during gestation.

Farm No.	No. of ewes.	Lambs born.	Warfa cases— Expected.	Actual.	Minerals fed from.	Lambing commenced.	Per cent. licks consumed.
1.	21	25	0	0	Dec. 16	Mar. 14	50
2.	10	15	1·3	8	„ 10	„ 12	100
3.	20	32	4·6	0*	„ 12	Apr. 4	100
4.	100	116	7·2	12	„ 12	„ 1	84
5.	19	31	2·0	4	„ 10	Mar. 24	100
6.	53	73	0·8	2	„ 14	„ 22	50
7.	17	32	3·8	1*	„ 12	Apr. 1	100
8.	32	41	4·6	11	„ 20	„ 7	100
8.	**272**	**365**	**24·3**	**38**	—	—	—

* See text (p. 1180).

Group C.

Treatment—1½ lb. minerals containing 0·3 per cent. Cu per ewe during gestation.

Farm No.	No. of ewes.	Lambs born.	Warfa cases— Expected.	Actual.	Minerals fed from.	Lambing commenced.	Per cent. licks consumed.
1.	90	112	12·8	0	Dec. 16	Mar. 28	87
2.	12	18	4·8	1	Jan. 16	Apr. 4	100
3.	34	59	1·2	0	Dec. 17	Mar. 20	100
4.	33	41	1·3	1	„ 17	„ 8	90
*6.	52	57	1·5	1	„ 27	„ 18	93
*7.	18	18	0·8	1	—	—	—
*8.	24	31	1·1	4	—	—	—
9.	25	32	4·5	1	Dec. 14	Apr. 1	72
5.	100	145	7·0	0	Jan. 31	Mar. 15	66
9.	**388**	**513**	**35·0**	**9**	—	—	—

* Sufficient licks were only supplied for farm 6. Flocks 7 and 8 were later added to farm 6 ewes and all ranged over a heather moor.

GROUP D.
Treatment—1½ lb. minerals containing 0·3 per cent. Mn per ewe during gestation.

Farm No.	No. of ewes.	Lambs born.	Warfa cases— Expected.	Actual.	Minerals fed from.	Lambing commenced.	Per cent. licks consumed.
1.	50	55	7·8	3	Dec. 12	Mar. 28	84
2.	27	45	2·8	4	,, 10	,, 18	89
3.	60	60	1·7	1	Feb. 1	,, 22	50
4.	16	22	7·3	16	Dec. 18	Apr. 1	100
5.	20	26	5·8	2	,, 11	,, 1	100
6.	14	22	6·1	17	,, 11	,, 4	40
7.	34	63	1·5	7	,, 23	Mar. 28	100
8.	7	7	2·0	2	Feb. 1	Apr. 1	100
9.	72	123	8·8	14	Dec. 17	Mar. 28	100
9.	**300**	**423**	**43·8**	**66**	—	—	—

GROUP E.
Treatment—none—negative controls.

Farm No.	No. of ewes.	Lambs born.	"Warfa" Expected.	"Warfa" Actual.
1.	25	41	—	6
2.	25	40	—	5
3.	18	23	—	5
4.	19	34	—	2
5.	50	80	—	12
6.	36	49	—	2
7.	86	96	—	6
8.	28	36	—	1
9.	14	22	—	5
10.	26	36	—	2
11.	40	50	—	3
12.	41	59	—	31
13.	15	27	—	6
14.	12	21	—	1
15.	12	15	—	1
16.	30	35	—	5
17.	60	75	—	18
18.	2	2	—	2
18.	**539**	**741**	—	**113**

FISH-WORKERS' WARTS

Why certain classes of fish workers on the East Coast are subject to warts is at present a mystery. They are frequently found, states the 1937 report of the Chief Inspector of Factories and Workshops, on the hands of workers who handle white fish, such as cod, sole, catfish, and haddock. Those who handle herring appear to be immune. Filleters are more frequently affected. Clerks and boxmakers whose jobs involve no contact with fish do not get them.

The warts are infective, but it has not yet been decided whether the fish carry the virus or whether the working benches become accidentally infected with human virus. Conditions on the benches appear to favour the growth of the virus. In some cases among filleters there are as many as 100 warts on each hand. There is usually a "parent" wart larger than the rest, and if this is removed the others disappear rapidly. In the case of "headers" the warts are usually on the thumb and index-finger, which are inserted into the eye and mouth of the fish to steady the head while it is being cut off. —*Manchester Guardian.*

DAIRY CATTLE REGISTER

Like all its predecessors, the twenty-first volume of the Annual Register of Dairy Cattle, published by the Ministry of Agriculture, is headed by British Friesian cows. This register is for cows with aggregate milk yields for three years. Britain's champion life-time production cow, the British Friesian Lavenham Chancery Third, owned by Strutt Parker (Farms), Ltd., of Essex, heads the register with 7,515 gallons. Follow in order ten more pedigree British Friesian cows, leaving the leading animal of all other breeds, namely, a Shorthorn, in the twelfth place with 5,469 gallons. Shorthorns, with 192 entries, show the best breed representation. British Friesians come next with 130 entries. Of the 192 Shorthorns, 22 gave above 3,500 gallons, while of the 130 British Friesians, 95 exceeded that production figure.

* * * * *

The Ministry of Agriculture and Fisheries has made arrangements to utilise the services of Professor Stapledon of the Welsh Plant Breeding Station in an intensive campaign for the improvement of grass land.

The Veterinary Record
SEPTEMBER 10TH, 1938.

Recruitment to the Colonial Veterinary Service

DURING the last two years we have commented editorially in many ways upon the Colonial Veterinary Service, sometimes referring to the character of the work to be done but more often emphasising the difficulties under which the men of the Service are at present working.

In a recent issue we again referred to the many unsatisfactory conditions associated with the Service, but we ended upon a note of optimism, arising from the fact that informal conversations had been established between certain members of the Colonial Office and representatives of the N.V.M.A. It was hoped that these conversations would lead to a general improvement in the conditions referred to and already it had been agreed that initial salaries should be raised to their former level. This agreement was tentative pending the resumption of consultation after the holidays, but meanwhile it was expected that no further development would take place until the conversations had been renewed and agreement arrived at upon such points as the long scale, staffing, the Veterinary Adviser at the Colonial Office, etc.

These facts could be gleaned from our editorial and from the reports we have published of the work of the Special Committee on Overseas Services.

The terms of the advertisement published in our issues of August 27th and September 3rd from the Director of Recruitment to the Colonial Office will therefore have come as a surprise to our readers. This has been clearly shown by the letters we have received and we wish to assure our members that but for exceptional circumstances such an advertisement would never have been accepted at this juncture without advising the Colonial Office to amend its terms. Unfortunately, the advertisement was received whilst the majority of the members of the Advisory Committee on Overseas Services were abroad at the International Veterinary Congress and it was therefore published by the *Veterinary Record* in the ordinary course of its business transactions.

It is our duty, however, to reiterate, before it is too late, our deep feeling that it is unwise for veterinarians to enter the Colonial Veterinary Service at the present juncture until more convincing evidence is received of the firm intention of the Colonial Office to improve the conditions. The only improvement so far made is the raising of the initial salaries for certain of the Colonies, and, thus far, only as a temporary measure. We have said before that the present time, as the result of an apparent lack of sympathy in the past at the Colonial Office and owing to the poor conditions associated with the Service, the majority of the men in the Service are unhappy. Not infrequently they leave the Service at an early date. Such small improvement as is mentioned in the advertisement is far too meagre to effect any substantial betterment and disappointment is likely to meet any young veterinarian entering the Service under the present conditions, particularly when his salary will probably terminate at £840.

Although the N.V.M.A. is not banning these posts it cannot do otherwise than advise intending applicants of the risk of disappointment and disillusionment they run if they enter the Colonial Veterinary Service under the present conditions applying to that Service.

It is strongly hoped that these conditions will be materially altered, but such hopes cannot as yet be accepted as reliable forecasts and it would seem to be folly so to evaluate them at present. We shall continue our efforts to collaborate with the Colonial Office in its attempt to improve the Service, and once better conditions are established we shall do all in our power to encourage and to strengthen the Service in every way open to us. It is our regret that such encouragement is not as yet possible.

* * * * *

Trace Elements

THE past 20 to 25 years have been years of remarkable progress in our knowledge of animal diseases. The list of conditions which have been described accurately and of which the causes have been determined in detail is a long one. It is perhaps well to realise that many of the disease syndromes which are now known to be due to a definite factor are not new conditions. Some were known under names which were perhaps purely environmental, *e.g.*, "salt bush sickness," "nakuruitis," etc., others were called by symptomatic names, *e.g.*, "blind staggers," "leg weakness," etc., while still others were known by terms which are little more than slang phrases.

Not the least important, and in some cases not the least spectacular, advances in our knowledge have been made in connection with the physiological importance of the presence or absence of one or more of those elements which are normally present in such minute amounts that they fully merit the term "trace" elements. In another part of this issue (page 1185) we publish an able and instructive general annotation on these trace elements, which we feel will well repay careful study by our readers.

Great Britain is happily free from any serious or widespread trace element deficiency, but in certain areas locally known diseased conditions have lately been shown to be due to the presence or absence of one or other of these substances. Some areas, notably the blown sand areas, are deficient in iron and/or copper or cobalt; parts of East Anglia are reported to have an unduly high fluorine content in the drinking water; a lack or deficiency of iodine is blamed for causing goitre in Somerset and Dorset, while in man, "Derbyshire neck" has been recognised for many years; molybdenum seems likely to be responsible for "teart" herbage areas in Somerset; perosis is occasionally reported among poultry, and there are other local and sporadic instances of injury resulting from a lack or excess of other trace elements. Apart from these, however, "nutritional" or "iron deficiency" anaemia of young pigs has become much more generalised during recent years than many of us realise.

With the constant intensification in our methods of animal production, and with the consequent greater demands made upon the food intake for every class of nutritive food substance, we cannot neglect the possibility that trace elements may assume a greater importance in future than they have done in the past in Great Britain.

It may well be that other elements than those already listed will be found to play an important rôle in the prevention or cause of disease. There are at present many gaps in our knowledge of the functions of the known trace elements, and there are still various conditions amongst animals of which our knowledge can only be properly described as hazy. Almost every country practitioner can point out in his practice, farms or areas where the growth of herbage plants, and the quality of plant foodstuffs are below normal, and where certain species of farm animals do not thrive normally. Locally the knowledge exists that some farms—or perhaps only some fields—are unsuitable for rearing young cattle or lambs. The causes are not yet elucidated, however, and it may be that some of these areas are suffering from a deficiency or an excess of trace elements.

We hope that after reading the annotation in this issue some practitioners will be stimulated to renew their efforts to seek a solution of their local problems, by considering whether some of them depend upon a presence or absence of one or other of these extremely potent, but tantalisingly elusive trace elements. Even if such efforts are not successful, we need no excuse for publishing the annotation already referred to, for we know of no other authoritative account of these substances which gives the essential information so concisely and yet so adequately. We commend its perusal to our readers.

ADMISSION OF FOREIGN DOCTORS

The effect of the further admission of foreign doctors to this country is discussed in a letter sent by the Medical Practitioners' Union to all medical men and to members of Parliament. The letter states that the Government asked for the admission of a further 500, the British Medical Association had said that 50 might be admitted, while the Trades Union Congress General Council had on the agenda of the Blackpool Congress a resolution proposing that 50 students and 50 doctors be admitted to this country yearly for four years. Dr. Alfred Welply, General Secretary of the Union, said that their representatives to the Congress had been instructed to oppose this item. The foreign doctors, he said, were not better qualified than our own, and were entirely ignorant of the habits and diet of the people. They did not understand the complexities of the hospitals and public assistance system, or the laws of compensation, national health insurance, unemployment, and so forth.

* * * * *

An outbreak of anthrax in a herd of cattle in a mountainous district between Dungiven and Maghera in County Down, following a recently reported similar case in the Glenarm (Co. Antrim) area has somewhat perturbed stock owners. Four cows have died of the disease and the fifth was slaughtered. Stringent precautions were immediately taken to prevent an extension of the outbreak, and as the area is isolated and away up in the Sperrin Mountains no spread of the disease is expected. During the four years ended March, 1937, there were only two outbreaks of the disease in all Ireland. As a matter of fact, the condition of livestock generally in Northern Ireland just now is reported to be excellent. Outbreaks of disease have been much lower than in an average season. A few cases of red water in cattle were chronicled, but to a very much less extent than was usual.

ANNOTATION

The Importance of Trace Elements in Veterinary Science

Introduction.

In biological usage the term " trace element " is an elastic one and refers to any element which commonly occurs in minute amounts in living tissues, plant or animal, whether it is known to exercise any specific physiological function or not.

If an element is found to be universally distributed in considerable abundance over the plant or animal as a whole, as in the case of phosphorus, or locally concentrated in some particular tissue as in the case of iron in the red blood corpuscle, some purpose is promptly assigned to it although it may be long before precise knowledge of all its functions is gained. Even when, as in the case of iodine, the total amount in the food eaten and in the animal as a whole is so small that the term trace element is justified, but local concentration found to be high in some particular organ, in this case the thyroid gland, attention is naturally focused upon it and it is assumed to be physiologically essential pending further research into its actual function.

But when, as in the case of cobalt and copper, the quantities found are not only exceedingly small but widely distributed throughout plant and animal tissues the tendency is at first to regard their presence as accidental and their physiological significance may be overlooked until some instance of entire absence, or presence in quantities below the usual traces, is encountered in the form of obscure deficiency disease. In the same way an element such as selenium may be widely distributed in both plants and animals but assumes no importance until it is encountered in certain plants in quantities above the usual traces and is manifested in the form of a toxicosis in the consuming animal.

The plant in taking up essential nutrients from the soil, until recently regarded as only ten in number but now known to be considerably more, incidentally takes up traces of numerous other elements merely because they are present in the soil solution or rendered soluble by action of its roots. Some of these are merely non-essential, as in the case of nickel which is always present but for which there is no evidence of useful function and without which, in water cultures from which traces of that element are specifically excluded, the plant grows equally well. Some are beneficial if the traces are exceedingly small but injurious if they are at all obvious, *e.g.*, copper, which by some plant physiologists is regarded as unnecessary, by others as essential in traces of the order " parts per hundred million " and yet is definitely harmful to some plants in water cultures containing as little as " parts per ten million." Indeed some elements, such as zinc, are regarded as inessential in the strictest sense of the term, but as increasing the resistance of certain plants to disease and stimulating crop growth, and it may even be that specific trace elements may be useful to specific plants. The element tungsten is not regarded as a general plant essential even in the most minute traces, yet stimulation of the early growth of peas and various cereals has been observed with low concentrations of sodium tungstate, the beneficial strength varying with the species. Readers interested in the plant as well as the animal side will find an excellent summary of current knowledge in Dr. Winfred Brenchley's article " The Essential Nature of Certain Minor Elements for Plant Nutrition " in *The Botanical Review*, April, 1936.

Since plant food is the basis of animal life any trace elements present in the plant are likely to be found in traces in the animal body as well, where they may exercise a beneficial effect, or a harmful effect, or be entirely inert. If sufficiently refined methods of analysis are employed it is possible to detect a very large number of elements in exceedingly small amounts, " parts per thousand million " up to " parts per hundred thousand," but it is often difficult to decide whether they are there by accident or whether they exercise a definite physiological effect for better or worse. A good illustration is the element cobalt, which only occurs in normal animal tissues in quantities ranging from parts per hundred million to parts per ten million and the presence of which was regarded as accidental until a few years ago, but is now known to be of great physiological importance in prevention of certain animal diseases in Australasia and elsewhere.

From the veterinary standpoint assessment of significance is further complicated by the fact that elements of physiological importance for one form of life are not equally important for another, and that even when a given trace element is significant for all, the quantities present may have a very different meaning for different plants and different animals. Different plants and animals may have different minimum physiological requirements for essential elements on the one hand or different tolerance for toxic elements on the other. Thus the requirements of plants for iron and copper

are below those of the animal in the sense that a pasture grass may be growing luxuriantly and be of high feeding value in the ordinary sense of the term and yet induce anaemia in the grazing ruminant. Certain forms of naturally occurring nutritional anaemia may also be prevented by supplying traces of cobalt to the grazing ruminant, although botanists can grow healthy plants in water cultures apparently free from this element. On the other hand the element boron is certainly required in significant amounts by most plants but if essential for animal life at all the traces always present in plants are sufficient in the sense that no "boron deficiency disease" has ever been recorded in animals. With regard to inessential but toxic trace elements, selenium is injurious to both plants and animals if present in quantities which cannot be disposed of in innocuous form or eliminated fast enough, but the relative tolerance is so different that good crops grown on seleniferous soils may rapidly produce characteristic disease in any higher animal to which they are fed, or which does not avoid seleniferous plants in selective grazing.

The purpose of the present annotation is to recapitulate briefly the significance of the commoner trace elements of interest to the veterinarian without actually reviewing the large bibliography which has become available in recent years. The space devoted to each is determined not so much by its economic importance as by the writer's estimate of the extent to which the information is likely to fill gaps in the existing general knowledge of the average reader of the *Veterinary Record*. The elements copper, cobalt, manganese, zinc, boron, iodine, fluorine, selenium and molybdenum may be dealt with individually. Elements such as aluminium, nickel, arsenic and lead, though common trace elements in living tissues, may be omitted because they are neither regarded as essential nor do they occur in plants in quantities injurious to animals. All four may sometimes occur in foods and water in undesirable quantities as "contaminants" but the harmful amount of aluminium or nickel is too high for traces to cause alarm, while the dangers of externally contaminant arsenic or lead are too well known to demand comment. A few years ago Bennetts in Australia suggested association between "trace lead" in milk of ewes and "enzoötic ataxia" of their lambs but has since abandoned that view in favour of "copper deficiency." As for arsenic the danger of cumulative or chronic poisoning from continuous ingestion of very small quantities is often exaggerated in the literature; absorbed arsenic is freely eliminated in the urine, the amount remaining in the animal body a few weeks after ingestion of a sub-toxic dose being physiologically negligible, and the amounts naturally present in oysters and certain flat fish occasioning no alarm to human consumers although well above the official limits adopted by health authorities for arsenic permissible in treated foods such as sprayed fruit.

In dealing with the nine elements already referred to, those associated with "deficiency diseases" may be taken first and those associated with "toxicoses" second.

Copper

Although the presence of traces of copper in plant and animal tissues has been recognised for over a century it is only over the last 15 years that they have received serious attention from mammalian physiologists and over the last five that the matter has been regarded as of serious consequence to the veterinarian—probably since the Dutch observations published by Sjollema in 1933. Yet by 1935 the literature had become so voluminous that Elvehjem in his article on "The Biological Importance of Copper and its Relation to Iron Metabolism" in *Physiological Reviews* (Vol. 15, No. 3) discussed about 200 publications in his selected field, while *Nutrition Abstracts* gives close on 40 references to new publications for 1936-1937.

The quantities of copper found in plant materials generally range from three to 40 parts per million and are highest in the more active organs of the plant although little is known concerning the precise rôle of the element. It has been suggested that copper can act as auto-oxidant or catalytic agent in certain vital functions of the plant and Lipman and McKinney, using water culture methods, found that flax grew well without copper until blossoming but that no capsules or seeds were produced; barley also needed copper for seed formation at the exceedingly low rate of one part per twenty million of nutrient solution.

The quantities found in animal tissues are also small but the variation is wider and the distribution more specific. In the mammal the liver is a storage organ for copper and figures may commonly run up to 20 p.p.m. (parts per million) as against about 1 p.p.m. for blood, the liver value being higher at birth than in later life. Certain marine animals contain very much more copper, commonly as haemocyanin, a specific respiratory copper protein complex, and the quantity diminishes as the organism rises in the scale of life until in the fishes, which are provided with the iron protein complex haemoglobin, the level is nearer that of the mammal. The blood of certain molluscs contains over 200 times as much copper as the blood of mammals, and that of certain crustaceans 100 times as much.

The blue compound haemocyanin is itself very high in copper, that isolated from the octopus containing 0·38 per cent., with an oxygen combining capacity of about one-third that of haemoglobin. A second naturally occurring copper complex is the highly coloured pigment turacin, in the feathers of the South African bird Turaco.

Apart from these outstanding instances of the significance of copper in certain lower forms of animal life, it was only after the studies of the Wisconsin workers, Hart, Steenbock, Elvehjem and Waddell, in 1925, on nutritional anaemia and factors affecting haemoglobin regeneration, that the element was shown to have a wide significance in mammalian physiology. Milk only contains small traces of copper, about 0·15 p.p.m., and also, as foodstuffs go, is low in iron—usually just enough to tide over the weaning period of the animal concerned. If young rats or other fast growing laboratory animals are fed on cow's milk, or on a synthetic ration sufficiently low in iron and copper, erythrocytes are not formed with sufficient rapidity and not normally packed with haemoglobin, so that a "nutritional anaemia" ensues. If a purified iron salt is now added to the diet, iron is stored in the liver but little formation of haemoglobin occurs in the red marrow unless traces of copper are also added. If copper is then substituted for iron the liver reserves of the latter are mobilised and haemoglobin is formed. Addition of copper alone to the deficient diet brings about an increase in the proportion of reticulocytes in the blood but the total haemoglobin formation is small. Addition of iron following the copper now brings about a second reticulocytosis but this time with normal haemoglobin formation. It would thus appear that copper assists in the mobilisation of iron in the body and acts catalytically in the formation of haemoglobin.

This fact is made use of in the treatment of those types of anaemia which respond to iron therapy if there is any suspicion of copper deficiency in the diet, the amount of copper commonly given being about one-tenth the amount of iron or even less.

In veterinary practice the commonest type of anaemia responsive to iron therapy is that of young pigs reared under sty conditions and denied the early opportunity of rooting at pasture. The demands of the modern fast-growing pigling for rapid haemoglobin formation seem to have outrun the capacity of the mother to supply sufficient iron, and probably copper, through the milk, so that a nutritional anaemia ensues. One treatment consists in painting the udder of the sow once a day until weaning with a mixture of 3¼ oz. of iron sulphate and ¾ oz. of copper sulphate (or less) dissolved in a pint of water and then mixed with a pint of treacle or syrup to make the solution sticky and more palatable.

Pasture grass and foodstuffs generally, usually contain quite enough iron and copper for animal requirements, but in 1933 Sjollema drew special attention to a form of "lecksucht" of cattle, sheep, and goats, in Holland, in which an actual deficiency of copper was incriminated and copper therapy alone was more effective than iron therapy alone. Over a quarter of a century ago Aston in New Zealand ascribed the "bush sickness" of cattle and sheep in the Rotorua district to iron deficiency and prevention of the disease could be achieved by providing licks of crude iron compounds. The "salt sick" of Florida, "nakuruitis" of Kenya, and "pining" of Scotland received the same explanation and responded to the same preventive measures but it is now known that catalytic trace elements are frequently involved in the aetiology of these naturally occurring "nutritional anaemias" — sometimes copper, sometimes cobalt and sometimes both, apart from ensuring sufficient iron for actual haemoglobin formation.

Quite recently Bennetts and Chapman (*Austral. Vet. J.* 1937, **13,** 138-149) have attributed anaemia of ewes and "enzoötic ataxia" of lambs, a disease similar to "swayback" in England, to copper deficiency and have claimed good provisional control by daily administration of small doses of copper sulphate to the ewes. No parallel observations on "swayback" have been made in Britain and it would be unwise to assume identity until evidence is available.

Amongst other problematic effects of trace copper may be mentioned the protective action against infection with *Mycobacterium tuberculosis* reported by Perla and the "insulin sparing" action in diabetes reported by Schmetz; both awaiting confirmation.

The question of copper in quantities higher than "trace" is beyond the scope of this annotation; it need only be mentioned that the gap between copper required for nutritional purposes and copper required to produce chronic or acute copper poisoning is enormously wide, and that ingestion of copper in quantities well above physiological requirements does not materially increase the copper content of blood or milk. Copper salts intimately incorporated in food are slowly absorbed and eliminated again after temporary distribution over the tissues, almost as fast as absorbed, so that the blood level does not rise unless the duodenum is suddenly flushed with considerable quantities in actual solution—a point to be considered in using copper salts as anthelmintics.

Cobalt

This element is widely distributed in plants in varying though always very small traces, but no definite relation has yet been established between plant growth and the presence of cobalt, although some botanical workers have suggested that it may exert some catalytic function; in great dilution it has been found to act favourably on growth of *Aspergillus*.

On the animal side, however, and particularly in direct relation to veterinary science, more so indeed than to the sister science of human medicine, it has sprung into amazing prominence over the last five years, notably in Australia and New Zealand, where cobalt is now regarded as an essential element in the metabolism of ruminants and "cobalt committees" are the order of the administrative day.

In Australia "Coast disease of sheep," characterised by progressive anaemia and cachexia, and terminating fatally unless controlled by transfer to "sound pastures," remained a baffling problem until about 1933, when Thomas on geochemical evidence, illuminated by apprehension of the German work of Waltner in 1929 on the polycythaemia following administration of traces of cobalt to rats, suggested that this element might be aetiologically involved. The work of Lines and Marston, published in 1935, demonstrated the efficacy of daily administration of so little as one milligramme (one twenty-eight thousandth part of an ounce) of cobalt in coastal disease, and the work of Underwood and Filmer on "enzoötic marasmus" of sheep and cattle in Western Australia, a disease similar to the "bush sickness" of New Zealand, showed that the biologically potent element in the iron ore "limonite," previously used with beneficial results as prophylactic, was actually cobalt. At present the cause of the group of "nutritional anaemias" in Australasia is regarded as a dual deficiency of cobalt and copper as trace elements, sometimes complicated by shortage of iron for structural haematopoietic purposes. Ewe weaners pastured on the blown sands at Robe developed fatal coastal disease which could be entirely controlled by treatment with cobalt and copper although not with either alone. Readers interested in the details of this work should consult Bulletin 113 of the Council of Scientific and Industrial Research of Australia, 1938.

In "Coast disease" the iron content of the liver is markedly increased and the copper content decreased, suggesting the kind of catalytic relationship already noted in referring to the storage of iron in absence of copper.

In New Zealand the work of Kidson, Askew, Dixon, Hopkirk and others, has demonstrated a similar aetiology for "bush sickness" at Glenhope and "sheep ailment" at Morton Mains. They have reported an abnormally low level of cobalt in the liver of affected animals, rising to normal with curative doses of cobalt salts.

In England J. B. E. Patterson has reported that the cobalt content of Dartmoor moorland soils upon which sheep suffer from anaemia is lower than on lowland soils on which they recover, but the evidence that the sheep anaemia of Dartmoor is aetiologically similar to the Australasian nutritional deficiencies is not yet adequate.

Greig in Scotland has the "trace element question," including cobalt, under consideration in relation to earlier work of the A.D.R.A. on "pine," and Lyle Stewart in Newcastle has the same question under investigation in relation to Northumbrian pining of sheep and its correlation with parasitic gastro-enteritis—stimulated by New Zealand observations in which cobalt deficient sheep seem to suffer more heavily from a given worm burden.

Manganese

The importance of manganese for plant growth is now well recognised although the quantity taken up from manganese rich soils is always small and varies considerably according to species: *e.g.*, 21 mg.p.c. (milligrammes per 100 grammes, or parts per hundred thousand) on the "dry matter" for the grass *Dactylis glomerata* as against less than 5 mg.p.c. for lucerne on the same soil.

Manganese deficiency in the plant is usually manifested by chlorosis or loss of green colour, affecting different plants in different ways. In tomato and cucumber plants the tops are first affected and yellowing of intravenal tissue produces a mottled appearance; the general growth is affected and flower buds may fall before opening. Sugar cane readily exhibits "manganese deficiency chlorosis" and the yield and quantity of sugar is affected. Tobacco plants not only show the usual deficiency chlorosis but are unusually sensitive to excess and may suffer on acid soils in which manganese is too readily available. "Grey-speck" disease of oats and wheat, "marsh-spot" in peas, "speckled yellows" of sugar beet and various other plant disorders are attributed to manganese deficiency in possible association with other factors.

Manganese is now also regarded as an essential trace element for animal life, appears to stimulate growth, be involved in haematopoietic function and in skeletal metabolism. Experiments on white rats on diets specially prepared to be deficient in manganese suggest that the element is essential for ovulation and development of the foetus during gestation, and it has

been suggested that the diet of children should contain about 0·2 mg. of manganese per kilogramme body-weight per day.

In general the small quantities of manganese naturally present in foods are sufficient so that "manganese deficiency disorders" are rarely reported and the recent work on "perosis," the "deforming leg weakness," or "slipped tendon," of chicks, becomes of special interest. Gallup and Norris (*Science*, 1938, **87**, 18-19) studied skeletal development of chicks from hatching to about two months old by X-ray pictures, on a low manganese diet (10 p.p.m.) and on the same diet supplemented with manganese (100 p.p.m.), and observed that the bones of the chicks on the lower intake were shorter and thicker than on the higher. Wiese, Elvehjem and Hart (*Poultry Science*, 1938, **17**, 33-37) produced "perosis" of chicks experimentally on rations high in calcium and phosphorus, and low in manganese. Addition of manganese *or* of rice bran prevented the disease, although in the latter case the effect was destroyed by autoclaving, suggesting a labile substance which either alone or in association with manganese prevents perosis.

The manganese content varies in different tissues and in different animals under different surroundings, *e.g.*, whole herring 0·13—0·90 mg.p.c. on fresh tissue, crayfish as high as 11 mg.p.c. and white rats down to 0·03 mg.p.c. Mammalian blood generally runs a "few parts per hundred million" (commonly 0·003 mg.p.c.) and is not substantially altered by feeding foods rich in manganese. The liver is apparently a storage organ and the manganese content of its tissue is much higher—quite commonly 100 times that of blood. Those interested in detail will find an excellent article by von Oettigen, "Manganese, Its Distribution, Pharmacology, and Health Hazards," in *Physiological Reviews*, 1935, **15**, No. 2, and later work adequately covered in *Nutrition Abstracts* and *The Veterinary Bulletin*.

The toxic dose of manganese is enormously high in comparison with nutritional requirements, and indeed is high in absolute terms even when given by intravenous injection. Absorption by the intestine from manganese-rich foods is slow and incomplete and there is no definite evidence of disorders associated with high natural manganese content of plants. Chronic manganese poisoning can, however, be produced experimentally and is known industrially.

Zinc

This element is apparently essential for normal growth and sporulation of *Aspergillus niger* and increases the growth of yeast although excess is toxic. Amongst the higher plants it seems to function as a stimulant to the growth of certain crops, increasing chlorophyll production and photosynthetic activity, and to act as a specific against certain diseases such as "mottle leaf" of citrus, "little leaf" of fruit trees and "bronzing" of tung trees.

Traces of zinc therefore naturally find their way into the animal economy and are apparently sufficient since no naturally occurring "zinc deficiency disease" has been reported, although rats experimentally fed upon a purified diet containing less than 0·02 mg. per day showed delayed intestinal absorption and decrease in growth rate. Bertrand and Bhattacherjee also claim to have shown that trace zinc functions in relation to physiological utilisation of one or more of the vitamins, and there is some evidence of its relation to insulin function—at any rate, injection of small quantities of zinc along with insulin delays the hypoglycaemic effect of the hormone.

Boron

This element is known to be essential for plant life and hence finds its way in traces into the animal economy where, however, there seems to be as yet no proof that it performs any specific function. Quantities in plants run from less than one part per million in cereals up to parts per hundred thousand in tobacco, potato, beans and peas. Although there is no known boron deficiency disease of animals the element is a definite limiting factor in health of plants. Boron deficiency is accompanied by abnormal tillering of wheat, which can develop to the flowering stage but not set seed properly. In water culture experiments sugar cane exhibits depressed growth, distorted and chlorotic leaves and definite stem lesions in absence of boron, although addition of as little as one part in five million to the nutrient solution establishes normal growth. "Heart rot," "crown-rot," or "dry-rot" of sugar-beet, and "brown-rot" of turnips, as also certain diseases of tobacco and other plants, are attributed to boron deficiency.

Iodine

An enormous volume of literature has accumulated around the iodine question but the outstanding features from a veterinary standpoint can be briefly given. The element occurs in minute traces in all plants and in appreciable amounts in some, *e.g.*, sea-weed. In water cultures of most plants it is toxic except in great dilution, and opinions differ in regard to its essential importance in plant life although it has been found to prevent crimping in lettuce and stem-rotting in tomatoes.

For the animal, however, it is a very important essential, the hormone thyroxin being an

iodine compound, although absolute requirements are exceedingly small and covered by "parts per ten million" in the food. The total in the human body is only about 25 mg., of which about 15 mg. is concentrated in the thryroid gland. Daily requirements are covered by about 0·05 mg. in the food per day and daily elimination in normal human urine usually ranges from 0·01 mg. upwards. Nevertheless it may not be present in sufficient amount in certain dietaries and water supplies, and then gives rise to disorders associated with thyroid activity, notably goitre. As soon as the store in the gland falls below a certain critical level the thyroid tissue increases in an endeavour to produce a sufficiency of its iodine-containing hormone to meet physiological requirements and thyroid hyperplasia results.

In this connection, however, it should be remembered that goitre can occur in localities not generally regarded as iodine deficient and that any factor which reduces the absorption of iodine or increases the utilisation of the thyroid hormone may also cause goitre. Thus continuous administration of certain organic cyanides can, by depressing tissue oxidation, produce a compensatory thyroid hyperplasia, and certain plants contain positive goitrogenic substances.

In British veterinary practice iodine deficiency is rare although rationed animals may sometimes receive sub-optimal quantities of iodine and benefit by iodised salt. On the other hand indiscriminate use of iodine supplements in excessive amounts may have adverse effects, although fortunately the margin between minimum essential amount and dangerous excess is wide. One part of potassium iodide per hundred thousand of dry meal, or about 0·05 per cent. in a mineral mixture, is more than sufficient and is harmless.

Certain areas in the world, however, are notably iodine deficient for farm animals. One of the best-known cases of pronounced deficiency occurring on a large scale was recorded from certain American states in which "foetal athyrosis" or "hairless pig malady" occasioned considerable losses prior to 1917. Piglings were still-born, or born hairless and died shortly after birth even when the mothers were apparently healthy. The trouble was obviated by including traces of iodide in the rations of the sows. Goitre in sheep, cattle and goats has been reported from Canada, Switzerland, New Zealand and elsewhere and prevented by the use of salt licks containing about 3 oz. of potassium iodide per cwt. In the case of sheep the "critical value" for iodine in the thyroid gland is about 0·03 per cent. on the fresh weight; below this the gland undergoes hyperplasia, in extreme cases reaching a weight even 50 times the normal.

In this country sporadic cases of congenital goitre in lambs have been reported from Somerset and Dorset, the drinking waters of which are known to contain less than the normal traces of iodine.

Fluorine

Traces of fluorine are normally found in plants and considerable quantities are not toxic but the essential character of the element is doubtful. Small quantities are normally present in animal tissues particularly in teeth and bone, and human urine commonly contains about one part per million, but if ingested in anything above the usual traces fluorine definitely interferes with bone metabolism. Quantities in drinking water such as the 5 p.p.m. at Maldon, Essex, cause "mottled teeth" and other dental defects, whilst in Northern Africa cases of generalised "osteopetrosis" have been described. There is also antagonism between fluorine compounds and thyroxin, and the accelerating influence of the latter upon development of tadpoles can be inhibited by the former, particularly by fluorotyrosine.

In veterinary practice spontaneous fluorosis is important in some parts of the world, notably Morocco where the disease "Darmous," common to man and all the domesticated animals, and characterised principally by dystrophia of all the permanent teeth, is particularly common in sheep in the rock phosphate areas. The teeth wear down quickly and the animal is unable to feed. The "Gaddur" of Iceland, affecting sheep grazing in volcanic areas, is also a fluorosis.

Fertilisers containing fluoride are not a source of danger unless directly ingested, since the amount transmitted through the plant is small, but the use of fluoride-rich ground rock phosphate in mineral supplements to cows has occasioned "fluorine cachexia" accompanied by reduced milk yield, exostoses on long bones and mandibles, hypoplasia of dental enamel and other features. The disorder can be experimentally produced in cattle in a few months by feeding about a gramme of sodium fluoride per day.

An outbreak of fluorosis affecting all animals including rabbits, recently occurred in Italy as a result of contamination of vegetation around the site of a new aluminium factory but such cases hardly come into ordinary consideration of trace elements.

Selenium

This trace element is important not because it is essential either to plants or animals but because it is much more toxic for the latter than the former, so that on seleniferous soils many healthy plants can accumulate quantities

of selenium which produce definite disease in animals consuming them.

Plants grown in water cultures with too high a concentration of selenium in absence of sufficient sulphur show a "snow-white chlorosis" but when slowly absorbed from soil many plants can store relatively large amounts of selenium without damage to themselves, different species showing enormous differences in accumulating the element. Thus the species *Astralgus bisulcatus* and *Astralgus missouriensis* are closely related botanically, yet growing on the same soil the former accumulated 1,250 p.p.m. and the latter only 3 p.p.m. *Astralgus bisulcatus* also acts as a "selenium converter" readily absorbing the element from virgin seleniferous shale soils and returning it in due course to the soil in more soluble form for absorption by other plants.

Selenosis of animals has not been conclusively demonstrated to occur in Britain although the element is widely distributed in traces in plant and animal tissues but in some parts of the world, notably in South Dakota west of the Missouri River, it has occasioned serious trouble in all stock including poultry, and grain produced in suspected areas fetches only minimum prices. The old "alkali disease," preventing profitable use of grazing, is now known to be chronic selenium poisoning. In horses, cattle and swine, selenosis is manifested by a depressed rate of growth, loss of hair, most conspicuous in the mane and tail of horses, abnormal development and sloughing off of hoofs.

Amongst poultry a conspicuous feature is non-hatchability of eggs, or hatching of monsters or weaklings. In experimental feeding of poultry on grain from affected areas the upper limit of safety appeared to be about 3 p.p.m.; 10 p.p.m. in wheat reduced hatchability from the seventh day of feeding onwards, while 5 p.p.m. had very little effect.

Selenosis can also be readily produced in other animals, failing appetite and stunted growth occurring very rapidly, and liver lesions being detectable in white rats fed on toxic wheat in as short a period as two weeks. On changing the diet normal growth is usually resumed but damage already done to internal organs is not completely repaired.

The "blind staggers" of Wyoming range cattle is a more acute form of selenosis than the "alkali disease" of Dakota and liver lesions apparently lead to death before loss of hair or hoofs occurs.

Although the element selenium is widely distributed in nature and when present in foods finds its way into all animal tissues, being generally highest in liver and kidneys, it is fortunately quite readily excreted in bile and urine and the danger is not great until a "chronic intoxication" level is reached, sufficiently high to induce irreversible damage to certain tissues; the urine of men employed in the extraction of selenium commonly contains a few p.p.m. without association with clinical symptoms.

In known seleniferous areas various control measures are being investigated to safeguard the health of stock and prevent the abandonment of farms; including the eradication of known "selenium converters," revegetating with forages which are not selenium accumulators, improving drainage, avoiding cultivation of cereals for sale off the land, and avoiding overstocking of grazing. Fortunately most animals learn to avoid selenium-rich plants and some pastures are safe if undergrazed but dangerous if overstocked.

Readers interested in detail may be referred to Moxon's article on "Alkali Disease" in Bulletin 311, South Dakota State College of Agriculture, 1937, for veterinary aspects, and to the article by Trelease and Martin on "Plants made poisonous by Selenium absorbed from the soil," in *The Botanical Review*, 1936, **2**, 373-376, for botanical aspects.

Molybdenum

This element also comes into the category of those which are widely distributed in traces, probably inessential, but toxic to animals in quantities which can be accumulated by healthy plants. "Molybdosis" has not yet been reported on an extensive scale but recently Watson (*Nature*, 1938, **141**, 153) has shown that the "teart" herbage of certain grazing areas of Somerset is considerably higher in molybdenum than that of "non-teart" areas and suggested that the scouring and reduced milk yield of cows in certain seasons may be caused by this. The chain of evidence is not yet complete but it is not unreasonable to presume that molybdenum, as well as other trace elements not yet fully investigated in relation to obscure diseases, may prove of significance to the British veterinarian.

H. H. Green.

The British record for milk yielded by a cow during one week has been broken by the British Friesian cow, Terling Graceful Tenth, bred and owned by Lord Rayleigh's Farms in Essex. Five months after calving, this cow produced 918 lb. of milk in one week, thus narrowly deposing the previous champion, Findlay Clara Second, also a British Friesian cow, whose record was 913 lb.

* * * * *

A cat owned by Mrs. Griffiths, of Hall Lane, Hindley, Lancashire, has died at the age of 21. It was claimed to be the oldest in England.

CLINICAL COMMUNICATION

Treatment of Sterility in Mares by Insufflation of the Fallopian Tubes

W. A. SMITH, M.R.C.V.S.,
Boyle, Co. Roscommon, Eire

On page 108 of the current volume of the *Veterinary Record*, a letter of mine written in criticism of an article on artificial insemination, mentioned a method which I have been employing for the last few years, of treating sterility by means of insufflation of the fallopian tubes. As, since its publication, I have received numerous inquiries for the details of the operation, I have decided to submit a brief description of my procedure.

It has been recognised by the medical profession for some time that in women many cases of sterility—both complete, and after one or more children—are due to a mild infection of the uterus which has given rise to light adhesions within the tubes resulting in their occlusion. These are sometimes, however, easily broken down and the tubes rendered patent again by gas or air pressure. CO_2 is the gas used by me as it is made up in suitable small containers.

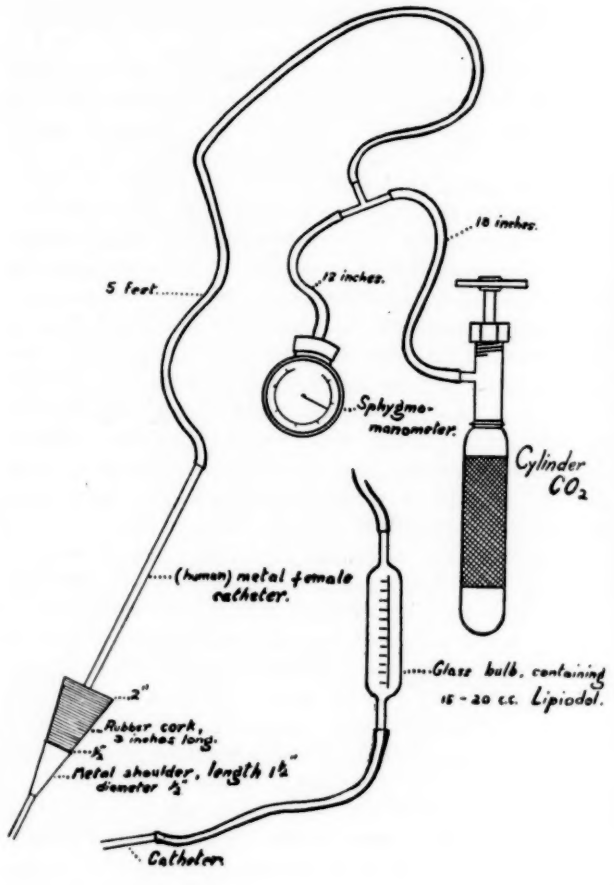
Briefly, the method consists in the injection of gas under pressure into the uterus through a catheter, with the *os* tightly occluded to prevent the escape of gas so that it is forced on into the fallopian tubes, thus dilating them.

The apparatus used by me for this purpose is a modification of that used by the gynaecologist and consists of a catheter (as shown in diagram) joined to a cylinder of CO_2 and a manometer.

The catheter used for the veterinary operation is a straight metal one, about 14 inches long. On its shaft, about 2½ inches from the distal end, is fitted a tapered pyriform metal plug 1½ inches in length, and above this again a conical solid rubber stopper, measuring ½ inch in diameter at its distal end, so that it is continuous with the slope of the metal plug, and two inches in diameter at its proximal end, the length being three inches.

The cylinder is connected by a rubber tube five feet long to a T-shaped junction.

On one of the horizontal limbs of the T is a rubber tube 12 inches long connected with a pressure guage, and on the other, a tube attached to a small cylinder of CO_2.



The pressure gauge used is an ordinary dial sphygmo-manometer registering up to 300 millimeters of mercury. If (see below) lipiodol injection is to be employed in addition to insufflation, a glass blub open at both ends with a capacity of 15—20 c.c., containing lipiodol is introduced at a point in the long tube far enough from the catheter to be well clear of the mare's vulva when the catheter is in place.

Before insufflation is performed, the mare should be carefully examined *per rectum* to eliminate any obvious causes of sterility such as cystic conditions of the tubes or ovaries; *per vaginam* to see that there is no abnormality of the *os uteri*.

Method

Examination of the mare for gross causes of sterility being negative, insufflation is proceeded with as follows:—

The right arm is vaselined or soaked in liquid paraffin and introduced with the catheter into the mare's vagina. The *os* having been found the catheter is introduced until the rubber stopper effectively plugs the *os* and makes a gas-tight joint. Holding the catheter securely in place the CO_2 is turned on very slowly and allowed to pass gradually into the

uterus until the manometer registers 150 mm. when the gas is turned off. If the pressure gradually falls the tubes are patent (and gas is escaping into the abdominal cavity)—if it remains steady there is a block in the fallopian tubes and more gas is allowed to run in until the reading shows 180 mm. The gas is again turned off and if the pressure is steady it is increased to 200 mm. and then to 250—280 mm. if necessary. The tubes usually dilate at between 200 and 250 mm. of mercury (shown by a fall of pressure on shutting off the CO_2).

Should there be no dilatation by 280 mm. the operation should be abandoned as above this there is a risk of rupturing the tube.

If the mare has been barren for a few years, and the tubes are found to be patent, good results have followed on an injection of lipiodol, which is introduced in exactly the same way as CO_2, using a glass bulb of lipiodol as described earlier in the article.

If lipiodol injection is to be employed, it should be done immediately after a heat, and the mare allowed to miss the next heat before she is sent to the horse.

Case I.—Thoroughbred mare 18 years old, had missed the two previous seasons. Rectal and vaginal examination revealed nothing abnormal. CO_2 gas was injected and at 240 mm. the gauge dropped gradually and when down to 180 more gas was injected up to 280. The gauge fell rapidly—this completed the operation. The mare was served 36 hours later and proved in foal.

Case II.—Thoroughbred mare, 11 years old, had missed three seasons and returned to the horse on the 21st day. Rectal and vaginal examination revealed nothing abnormal. Gas was injected to a pressure of 200 mm. and the gauge remained steady. At 280 the gauge fell rapidly. The mare was served next day and proved in foal.

Case III.—Thoroughbred mare about 15 years old. Had bred some good foals and failed for two or three seasons. In the end was sold and failed one season with the purchaser. She was examined *per rectum* and *per vaginam* and showed nothing to account for this.

Gas was injected to varying pressures up to 280 mm. with no falling of the gauge. The pressure was increased to nearly 300, when the gauge began to fall very slowly. She was served next day and returned to the horse on the 21st day. Gas was again injected up to a pressure of 280 m.m. and the pressure fell more or less rapidly. After service she proved in foal.

Case IV.—Mare ten years old. Rectal and vaginal examination revealed no diseases. Gas was injected to 150 mm. pressure, when the gauge gradually fell. On increasing the pressure to 180 m.m. the pressure fell more rapidly. The mare was sent to the horse but returned on the 21st day. No further treatment was tried as the owner decided that it was of no use to continue.

Conclusion.—The method is simple, and the operation requires no special skill. It is definitely claimed that after its use a fair proportion of mares prove fertile.

ABSTRACTS

[**The Importance of Vitamin C in Bacterial Infections: an Experimental Study.** (Trans. title.) Weitzenburg. (1938.) *Arch. wiss. prakt. Tierhlk.* **73.** 3. 188-204.]

Guinea-pigs fed either for 15 or 70 days on a diet rich in vitamin C were found to be more resistant to infection wth *Bact. cuniculi septicum* than were animals fed a diet deficient in this vitamin. Among the former animals, a smaller number of each group died and deaths occurred at a longer interval after infection. The vitamin C content of various organs of the animals was estimated and the greatest diminution due to infection was found in the adrenals. Histological examination of the adrenals showed a marked diminution of cortical lipoid in animals succumbing to the infection.

E. G. W.

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[**Equine Anhidrosis or Dry Coat.** Whitworth, S. H. (1936.) Ann. Rep. Vety. Dept. of S.S. and F.M.S. 1936. pp. 32-35.]

Equine anhidrosis, a disease of race-horses prevalent in India and Malaya and characterised by the animals possessing a very dry coat, it said to be of dietetic origin and to be associated with an avitaminosis C, a lack of sodium chloride and the hypofunction of the adrenal cortex. Two cases of this disease were fed a diet rich in vitamin C and sodium chloride and in order to compensate any adrenal hypofunction doses of whole gland powder were given daily. In addition, various subsidiary treatments were tried including the feeding of glucose, potassium, and sodium bicarbonate, potassium iodide, adrenalin, and finally yeast to provide vitamins of the B complex. To combat the anaemia present a mixture of iron, copper and strychnine was administered.

The following observations were made as a result of the above experiments. The feeding of foodstuffs rich in vitamins A, B and C, caused a marked improvement in the skin lesions but not in the ability to sweat. The adrenal gland powder did not appear to produce any effect or improvement in condition but it is suggested that this powder may have produced the marked improvement which took place in the anaemia.

Climatic conditions seem to play a big part in the production of the dry coat since animals sent to high altitudes improve quickly when the temperature is about 67° F. and the relative humidity much higher than on the plains. The use of first-class air-conditioned stables is suggested for horses kept on the plains.

J. S.

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[Pathological Changes in the Larynx and Trachea in Fowls with Vitamin A Deficiency. (Trans. title.) Seifried, O., and Sassenhof, L. (1938.) *Arch. wiss. prakt. Tierhlk.* **73.** 3. 232-242.]

The clinical symptoms and macroscopic *post-mortem* lesions of vitamin A deficiency in fowls may be confined to the larynx and trachea; such cases often cannot be differentiated from laryngotracheitis or fowl pox on macroscopic examination alone. Vitamin A deficiency is characterised by a striking whitish appearance of the mucous membranes of the larynx and trachea.

Differential diagnosis is usually possible, even in early cases, by histological examination. In both spontaneous and experimental vitamin A deficiency, the normal columnar epithelium of the larynx and trachea is replaced by epithelium of the keratinised squamous type. In infectious laryngotracheitis there is usually a haemorrhagic inflammation of the mucous membrane of the larynx and trachea and typical intranuclear inclusion bodies are present. In fowl pox, the lesions in the mucous membranes are similar to those occurring in the skin—swelling and degeneration of the epithelial cells and the presence of Bollinger bodies.

Experimental inoculation is recommended in all doubtful cases. An emulsion of the lesions is inoculated into the scarified skin (comb, or wattles) and into the mucous membrane of the buccal cavity and larynx of two fowls. In this way, fowl pox and laryngotracheitis, are readily diagnosed and vitamin A deficiency excluded.

E. G. W.

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[The Parasitic Helminths of Sheep in Scotland. Robertson, D. (1935.) Comptes Rendus du xiie Congrès International de Zoologie, Lisbonne, 1935, Section x, pp. 2013-2043.]

From an analysis of questionnaires sent out by Robertson to various sheep farmers throughout Scotland, it was noted that 54 per cent. of those who replied reported losses from suspected worm infestation and that 75 per cent. of those who suspected such losses were attempting to check the latter by the use of anthelmintics. Other methods used, in order of frequency, were change of pastures, decreasing flocks, feeding concentrates, ploughing up pastures, liming pastures, grazing with cattle, use of mineral licks, change to foggage, salting pastures and use of salt licks. Information on the numbers and species of worms present, the degree of infestation, and the pathological effect of the infestation on the organs parasitised was obtained by visits to 61 farms reporting losses. Of 33 lambs up to six months old which were autopsied, none was found free from helminths and 97 per cent. were infested with *Ostertagia circumcincta*, 51 per cent. showing a heavy infestation. The author concludes that this nematode is the most important economic and pathogenic one in Scottish lambs. No flukes were recovered from these lambs but symptoms of fascioliasis were noted in five of the eleven hill flocks inspected, while symptoms of "gid," due to *Coenurus cerebralis*, were seen at ten of the 61 farms visited, the disease appearing commonest in Inverness-shire. *Moniezia expansa* was recovered from a third of the lambs examined, but in small numbers, and pathogenic infestations were not observed at any other time. *Post-mortem* examinations of abattoir lambs in Aberdeen during May to October showed that *Moniezia* was commonest in May and tended to become less common during the summer but with an increase again in September. The earliest occurrence of the hookworm, *Bunostonum trigonocephalum*, was mid-July, the largest numbers being found towards the end of September and beginning of October; the author considers that the species does not appear to be particularly dangerous. The whipworm, *Chabertia ovina*, appears to be pathogenic where it occurs in large numbers, 60 or over. The commonest species of lungworm in Scottish sheep is *Muellerius capillaris*, followed by *Dictyocaulus filaria* and *Protostrongylus rufescens*. Various tables are included in the paper giving the number and species of helminths recovered from sheep examined, the degree of infestation of the most important forms and the frequency of occurrence of all the species recovered. The author records the occurrence of *Ostertagia ostertagi* from the abomasum of sheep for the first time in Scotland.

J. N. O.

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[Treatment of Worm Diseases with Arsenosolvin and Antimony Tartrate. (Trans. title.) Bernard. (1938.) *Deuts. tierärztl. Wschr.* 1938. 25. pp. 386-390.]

The treatment of 30 horses with arsenosolvin intravenously, followed by antimony tartrate *per os*, in an endeavour to combat the symptoms

of sclerostomiasis and ascariasis, is described. The antimony tartrate is administered on the day following the injection of arsenosolvin. About three such injections are given in a week. As judged from a faecal count the effect was most beneficial, whilst the general condition of the animals showed great improvement. The author recommends this course of treatment for worm infection in horses.

D. J. A.

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[**Biology of Dictyocaulus arnfieldi.** (Trans. title.) Wetzel, R., and Enigk, K. (1938.) *Arch. wiss. prakt. Tierhlk.* **73.** 2. 94-114. 8 text figs.]

In two consecutive papers, Wetzel and Enigk record their observations on the biology of *Dictyocaulus arnfieldi*, the equine lungworm. In the first paper the authors deal briefly with the nomenclature and systematic position of the parasite; they also give brief descriptions of the adult male and female worms and mention the recorded hosts and geographical distribution, which includes England. The development of this lungworm is direct and the authors give descriptions of the egg, free-living first and second stage and the infective, third stage larvae. Infection is *per os* and the ingested third stage larvae migrate from the gut wall in the lymph stream to the mesenteric lymph glands where the second moult is completed. From the second day after infection the larvae migrate into the lungs *via* the ductus thoracicus and right heart; the third moult occurs on the fifth, and the fourth moult between the tenth and twelfth days after infection. Descriptions of the fourth and young fifth parasitic stages are also given. The authors found that, in the horse, first stage larvae were passed in the faeces 39 days after infection.

In the second paper the authors discuss the host-parasite relationship. They observe that *D. arnfieldi* appears to be better adapted to the ass than to the horse, although in neither host could an age resistance be demonstrated. The parasites settle down almost exclusively in the main lobes of the lungs. The third and fourth stage larvae may be found in the lung parenchyma but the young adults migrate, from about the twelfth day, into the bronchioles and small bronchi, where they produce, in the sites where they settle down, a catarrhal bronchitis accompanied by infiltration of eosinophil leucocytes. *D. arnfieldi* infestation appears, according to the authors, to be linked up with moist regions, especially those with a cool climate. The possibility of treatment with iodine in potassium iodide by Koulsikov and Tamarine's method is mentioned. This consists of intratracheal injections of 200 to 250 c.c. of aqueous Lugol's solution (1:2:1500) while the animal lies on its back and slightly inclined (30 to 40°) to one side, the head being slightly raised. The medicament thus reaches the main lung lobes, where the parasites normally settle down. Treatment requires to be given on two con ecutive days, the animal being inclined to one side on the first, and to the other side on the following day. Treatment in the standing position should be rejected as both risky and ineffective.

J. N. O.

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[**A New Apparatus for Treating Warbles.** (Trans. title.) Bartels. (1938.) *Tierärztl. Rdsch.* **44.** 13. 203-204. 3 text figs.]

Bartels describes, with illustrations, a new and recently patented apparatus designed for the treatment of warbled cattle with derris solutions. The fluid reservoir consists of a zinc-plated box, 10×30×40 cm., shaped to fit the back of the operator, to whom it is attached, like a knapsack, by two straps. On top of the container is a filling device and a valve, while at the bottom there is an outlet tube incorporating a stop-cock, which controls the flow of the dressing solution, and attached to this is a flexible tube, the distal end of which fits into a hole in a brush. A valve device in the orifice of the brush controls the flow of solution so that by pressure on a button the bristles can be saturated with fluid from the container. A detachable pump, when fixed to the valve opening on top of the reservoir, supplies the necessary air pressure to force the fluid out. When not in use, the apparatus need not be laid aside and the brush and pump may be hung on two hooks, each conveniently placed on the carrying straps. The author claims that the apparatus is extremely simple to use and that, after the removal of the crust from the warble hole by the combined action of the fluid and friction of the bristles, penetration of the dressing into the cyst is effected by a further few strokes of the derris-laden brush. The apparatus facilitates treatment because the operator has greater freedom of motion and becomes less easily fatigued than when having to dip the brush into the fluid or to apply the dressing from a bottle. In addition, this apparatus works with greater economy, a point not to be disregarded in connection with the prices of derris preparations. Although the cost is not mentioned, the place from which the apparatus may be obtained, in Germany, is given.

J. N. O.

REVIEW

["**Perspectives in Biochemistry.**" Edited by J. Needham and D. E. Green. Published by Cambridge University Press. Price 15s. net.]

The early reprinting of this volume, first published 1937, is sufficient proof of its general appeal to all those interested in an understanding of the mechanism of life. This general appeal is indeed a great tribute to the leader—Sir Frederick Gowland Hopkins—to whom this book is presented by the past and present members of his laboratory at Cambridge, for it might be expected that no group of workers coming from one laboratory and writing upon the branches of knowledge in which they have specialised would produce a volume of general interest. Surely it would be impossible for a similar book to be produced by the followers of any other scientist.

The essays themselves are authoritative and up-to-date and they have the refreshing character associated with the writings of authors actively engaged in furthering the knowledge about which they are writing and who have frequently allowed themselves to hazard a guess on future developments. The subjects of the essays range from work on the recently discovered chemical organisms which play such an important part in the development of the embryo to the social implications of biochemistry. Cellular physiology is described under its various headings of tissues or micro-organisms, the different aspects of the mechanisms by which the organism gets its energy are well described, the importance of the chemical structure of living surfaces is closely indicated and a variety of other essays deal with such topics as the chemical regulation of insect growth, the biochemistry of flower colour variation, the biological function of magnesium, blood coagulation, mental disorder, vitamins D and C, toxamins in food and Drugs and Mankind. Truly an excellent repast and one that will be enjoyed by all those wishing to understand life processes.

Taken as a whole the work may be said to bring out very clearly the complexity of these processes and yet above this is emphasised the beautiful precision with which one process dovetails in with another. The book can be well recommended. As a tribute to the inspiration of a great leader of science it is unequalled.

N.V.M.A. DIVISIONAL REPORT

Lancashire Veterinary Association*

MEETING AT LIVERPOOL

A general meeting of the Association was held on Wednesday, May 11th, 1938, in the Department of Veterinary Pathology, University of Liverpool.

The President, Mr. G. Mayall, occupied the chair and there were also present: Messrs. G. O. Davies, W. Woods, H. G. Hewetson, F. A. Ball, G. C. Webster, P. T. Lindsay, H. R. Hewetson, T. Wilson, C. F. Shawcross, J. H. White, A. Rutter, G. N. Shirley, R. B. Hornby, E. A. Pearce, J. McGhee, J. F. Craig, R. C. Locke and Mrs. K. G. R. Kelly.

Dr. R. A. Morton, Messrs. J. A. Brown, R. E. Williams, R. B. Wood, M. Dalby, E. J. Hodgkinson and G. H. Arthur were present as visitors.

Apologies for absence were received from Messrs. A. L. F. Mullen, K. D. Downham, G. H. Locke, T. Millington, Sir F. Hobday and Mr. J. C. Baird.

Paper.—An alteration in the order of the agenda was approved and Dr. R. A. Morton, D.Sc., PH.D., F.I.C., of the Chemistry Department, University of Liverpool, was called upon to give his paper, entitled "On Recent Vitamin Studies."

At the conclusion of the address certain members contributed to a discussion of the paper. [Dr. Morton's paper is reproduced and a report of the discussion is given, at the commencement of this issue of the *Record.*—*Editor.*]

The President said they had heard a very interesting lecture from Dr. Morton, and one that had brought them, or should bring them, nearly up to date with regard to the question of vitamins. He thought it would be their unanimous wish to accord Dr. Morton as hearty a vote of thanks as had ever been passed to anybody who had addressed them. Therefore, he asked some member to move that they accord Dr. Morton the best thanks of the meeting for his very excellent and informative address.

Mr. Woods observed that he was pleased to be afforded the opportunity of moving a particularly hearty vote of thanks to Dr. Morton for having told them so much that they had not known before, and something which might prove of value to practising veterinary surgeons. The knowledge now possessed with

*Received for publication on July 23rd, 1938.

regard to vitamins had extended very much since his (the speaker's) time, and he had been very pleased to hear all that Dr. Morton had told them. ("Hear, hear.")

Professor Craig, seconding the motion, commented that he did not think it required any words of his to commend it to the gathering.

The compliment was bestowed with acclamation.

Minutes of the Last General Meeting.—The Acting Secretary, Mr. R. C. Locke, stated that the Minutes of the previous General Meeting had been published in the *Veterinary Record*, and a motion that they be taken as read was carried.

Correspondence.—Letters of resignation were read from Mr. E. J. Burndred, intimating that he had left Lancashire, and Mr. H. Burrow, who stated that he found it increasingly difficult to attend since going to Derby.

It was resolved to accept the resignations with regret.

A letter from the Secretary of the Lancashire County Veterinary Officers' Section, reporting the proceedings of a meeting held at Preston, on March 19th, was read. Discussion followed but no motion was put.

A letter was read from the General Secretary of the N.V.M.A. enclosing a report of the Poultry Technical Committee and asking for observations. A reply was requested by May 30th, and it was resolved that the matter be referred to the Council.

Council Report.—A Report of the proceedings of the meeting of Council held on March 16th, 1938, was read and adopted.

There were no nominations for membership, and in the absence of further business the President declared the meeting closed.

J. C. Baird, *Hon. Secretary.*

SHEEP TICK CONTROL

Members of North-East Scotland Tick Committee, visiting Mr. D. L. Middleton's Fettercairn Estate recently, saw the results of dipping in keeping down the tick pest in sheep.

Mr. Walter Moore, in charge of sheep pest control at the North of Scotland Agricultural College, said this was one of the farms severely affected by sheep tick when the College first started its survey in 1936. The tenant had then lost £1,000 in three years as a result of tick. Serial dipping had been introduced, and the incidence of tick brought to a very low level. Mortality had been reduced from 34 per cent. to 3 per cent.

Mr. Moore stated that he was convinced that tick was a recent importation into that part of the country. He stressed the importance of getting acclimatised sheep for tick-infested land. Otherwise there must be heavy losses. One of the most useful things they had discovered was that to clean arable land of the tick they had to dip sheep when removing them from the hill to the low land. The serial dipping had to be done every three weeks.

THIRTEENTH INTERNATIONAL VETERINARY CONGRESS

(*Continued from page* 1165)

Congress Discussions

On Monday, August 22nd, at 11 *a.m.*, Section I considered recent progresses in haematology of animal diseases, and before a large audience, Captain Barker delivered a very interesting paper on the results of blood plasma estimations on 300 cases of metabolic disorders in cows, together with a classification of the various syndromes and their relation to the blood picture. Therapeutic measures were also discussed. Milk fever, acetonaemia, grass tetany, lactation tetany, transit tetany and pregnancy toxaemia are confined to the female bovine and this was suggested as being primarily due to the recurring physiological crises of oestrus, pregnancy and lactation to which they bear a very definite time relation.

Hjärre and Berthelsen of Stockholm dealt with the blood picture in infectious equine anaemia. In this disease, the leucocytes undergo changes conforming in general to those described by Schilling in infectious diseases in man, *i.e.*, a phase of neutrophile defence, followed by one of monocytic defence, and then one of predominance of lymphocytes and eosinophils indicating recovery. Qualitative changes also occur in the neutrophil leucocytes during the febrile phase. The changes in the bone marrow and the method of obtaining the latter in the horse by sternal puncture were also described.

The special reactions of the haemopoietic system in the domestic animals were discussed by Professor Wirth, of Vienna. Animals were deprived of approximately half their total blood content by bleeding or heart puncture and the process of regeneration was studied in blood smears taken daily. In the horse, very few regenerative cells were seen in the blood: there were no reticulocytes and basophil punctation was absent. In all other species the number of regenerative forms of red cells was very large. In the dog and cat, erythroblasts and Jolly bodies were very numerous and polychromasia, and reticulocytosis were marked. Basophil punctation was exceedingly rare. In the sheep and goat basophil punctation and polychromasia were prominent, whilst erythroblasts and Jolly bodies were rare. In the pig, there occurred reticulocytosis and polychromasia, erythroblasts were rare, and basophil punctation was absent. The results in bovines up to the present indicate that the changes was similar to those in the horse.

It was clear that one could not refer to an anaemia in the horse as being "aregenerative" since this was the normal reaction in this

species; in the goat or dog, on the other hand, such a response would be significant and, in man, would warrant a bad prognosis.

The reason for this difference in the response of the haemopoietic system in different species is not known, but the amount of splenic tissue, the activity of the bone marrow, and difference in diet were suggested as possible factors.

On Tuesday, August 23rd, at 10.30 *a.m.*, Section VIII discussed the inspection of tuberculous animals for slaughter. The lecture theatre was packed to overflowing for the three papers on this subject delivered by Nieberle of Leipzig, van Oyen of Utrecht, and Césari of Paris.

Professor Nieberle gave a short summary of the pathogenesis of tuberculosis in cattle, stressing the importance in meat inspection of the rapidly spreading, diffuse, caseating form of tuberculosis in such organs as the lung, udder, kidney and uterus with similar changes in the regional lymph nodes. Such forms were accompanied by a tuberculous bacillaemia and in histological sections it was extremely easy to find tubercle bacilli actually within small blood vessels at the edge of the caseating areas. This point was admirably illustrated by photomicrographs. Nieberle's colleague, Meyn, found tubercle bacilli by cultural and guinea-pig inoculation in the flesh of 41 out of 49 such cases. The importance of this type of tuberculosis, especially where raw or partially cooked meat was consumed, was clearly very great.

Tuberculosis of the bone marrow, at least in pigs, was usually multiple, and a thorough examination of the skeleton was therefore advisable in such cases.

Césari dealt with the details of inspection of tuberculous animals and, in conjunction with Nieberle, formulated a scheme for judgment of tuberculous carcases based on the recent advances in the pathogenesis of tuberculosis:—

(*i*) The whole carcase is unfit for food if affected with extensive lesions of the musculature, marked emaciation, oedema, or absence of *rigor mortis* (determine the *p*H of the meat).

(*ii*) The carcase is conditionally fit for food (*i.e.*, it shall be sterilised before sale for food) although there exists a recent blood stream generalisation which may occur as follows:

(*a*) primary infection (*e.g.*, of the lungs) with acute generalisation and miliary tubercles in other organs;

(*b*) acute generalised miliary tuberculosis of the lungs;

(*c*) rapid diffuse, caseating tuberculosis of an organ, *e.g.*, lung, udder, uterus, with miliary tubercles often demonstrable only microscopically;

(*d*) slowly-generalising tuberculosis of an organ with miliary lesions in other organs.

[*Note.*—Special care must be taken to recognise these cases in animals slaughtered in emergency. Miliary tubercles in the liver and kidney are often found only on histological examination.]

(*iii*) The case is treated as one of localised tuberculosis in the absence of the conditions listed under (*i*) and (*ii*). In addition:—

(*a*) Tuberculous organs are unfit for food. Tuberculous lymph glands are to be taken as indicating infection of the organ which they drain.

(*b*) Tuberculosis of the bones, articulations or tendon sheaths shall result in complete condemnation of the carcase.

(*c*) If tuberculosis is present in an intramuscular lymph gland, all such glands should be examined, and also the bones of affected quarters.

(*d*) Tuberculosis of the mesenteric glands should result in their complete removal and the condemnation of the stomach and intestines. The mesenteric fat may be used for food if it is first rendered down.

(*e*) In cases of tuberculosis of the visceral layer of a serous membrane, the lesions should be removed and the fat rendered down before sale for food.
If the parietal layer is affected, this should be stripped and the underlying tissue seared with a flame; alternatively the underlying musculature should be removed from the quarter and, in fore-quarters, the wall of the thorax should be condemned.

Unfortunately, Césari was not present to read his paper, which was communicated by a colleague. He appeared to be unaware of the recent work of Nieberle and his co-workers and considered there was no scientific knowledge as to the degree of infection of meat with tubercle bacilli and of its danger to man. He considered there to be no justification for any alteration in the present practice of meat inspection.

A very interesting and lively discussion followed the reading of these communications. Meyn, who carried out the bacteriological examinations recorded by Nieberle, gave an account of a rough quantitative examination of the number of tubercle bacilli present in tuberculous meat. The number of colonies which could be grown from the juice extracted from 1 gm. of meat varied from 1 to 85. This

number was, of course, much smaller than the real number present, as many organisms did not grow or remained in the musculature and, in addition, some colonies arose from more than a single organism. The same method applied to tuberculous milk, using the deposit from 10 c.c. of milk, gave colonies varying in number from less than 10 up to innumerable, many being within the range given for tuberculous meat. In some cases no organisms could be recovered on culture, but positive results were obtained on guinea-pig inoculation.

Professor Müller, of Munich, considered that the question of passing a resolution drawing attention to the need for revision of our methods of meat inspection in tuberculous animals should be deferred as insufficient data were at present available. He stated that there existed no record of a single case of tuberculosis in man proved to be due to eating tuberculous meat. He considered that the danger from tuberculous flesh was very small, that from tuberculous organs being much greater, as he thought they were more heavily infected. Van Oyen suggested that all material containing tubercle bacilli, no matter in what number, should be condemned. Owing to the enormous variation in meat inspection regulations in different countries, standard international regulations should be formulated. *The aim of meat inspection should be to secure sound meat from healthy animals.*

Nieberle, in his reply, criticised Césari for basing his remarks on views of the pathogenesis held 30 years previously, no note being taken of recent advances. Regarding Müller's contention that there was no recorded case of human infection from tuberculous meat, he suggested that no experimental work had yet been carried out to test the matter! During recent years, the mortality from tuberculosis in man had fallen, but the number of human beings infected during childhood had also fallen and a larger number now became first infected during the second and third decades. At this age there existed a potential danger from infected meat eaten raw or insufficiently cooked. He suggested that the question of a resolution should be put to the vote, but after some discussion the motion was defeated. One speaker suggested that the veterinary profession should take the lead in suggesting a reform rather than wait for the medical profession to take it out of their hands at a later date.

On Thursday, August 25th, at 11 *a.m.*, Section III discussed leukosis of cattle and other domestic animals.

This paper dealt almost entirely with bovine leukosis, a disease extremely common in certain parts of Germany and recorded in most countries of the world. Professor Dobberstein, of Berlin, dealt with the general aspect of the disease and Professor Seifried of Munich dealt with the pathological anatomy. The latter illustrated his remarks with a number of photographs.

Leukaemia was a tumour-like proliferation of the haemopoietic tissues. It was sub-divided according to the cell maturity into myelosis, lymphadenosis, lymphosarcomatosis, and haemocytoblastosis. In animals, it was most commonly aleukaemic, *i.e.*, there was no excess of white cells in the blood. Bovine leukosis was continually increasing in Germany. It usually affected animals, five to eight years old; female animals were more often affected. The disease ran a chronic course, the symptoms varying greatly with the localisation of the lesions. The latter might be diffuse in character or more circumscribed and tumour-like. The lymphatic glands were the commonest site and the organs most commonly involved were the liver, mucosa of the intestinal and urinogenital tracts, the myocardium and the subserous tissues. The respiratory tract and skin were rarely involved.

Proliferation commenced among the indifferent mesenchyme cells in the wall of vessels and in other reticulo-endothelial cells. There followed an uncontrolled production of primitive white blood cells. The aetiology of the condition had not yet been established; there were marked similarities to fowl leukosis and to leukaemia as it affected the guinea-pig and white mouse.

Experiments in America had shown that the production of leukaemia in mice by injection of cells from an affected animal only succeeded in mice of particular strains and that this susceptibility was transmitted to the offspring. Susceptible mice were obtained from America and 80 per cent. of them developed leukaemia after injection of tissue from an infected mouse; injections were also successful in their progeny. Similar injections in mice obtained in Germany were without result. It was possible that heredity played an important part in the incidence of the disease in cattle and this might explain the peculiar distribution of the disease in Germany.

During the discussion, Dr. Müssemeier mentioned the very frequent occurrence of the disease in a particular herd of cattle, all the progeny of a single bull.

. . . . .

A large number of Congress members attended a special afternoon performance of the Swiss pastoral play "William Tell" on Saturday, August 27th. A considerable proportion of the 2,000 seats, all of which are under cover and command an excellent view of the magnificent natural stage, were reserved for

members at reduced prices. The wonderful setting of the play, the fine costumes and the superb acting of the 350 performers will long remain in the memory of those who witnessed it.

The part of William Tell was played by Dr. H. Tschumi, a veterinary surgeon practising in Interlaken. In the special supplement of the local newspaper, *Oberländisches Volksblatt*, he contributed an article on "Contagious Abortion in the Mountain Regions." This supplement contained addresses of welcome to the Congress members and numerous articles on veterinary topics, including "The Control of Contagious Diseases of Animals in the Canton of Berne," "Artificial Insemination of Cattle," "Diseases of Fowls," "Diseases of Young Pigs" and several others. A similar supplement was issued with the *Neue Zürcher Zeitung*, the daily newspaper of Zürich, on August 21st. In addition to addresses of welcome there were three articles of interest to veterinarians—"The Relation of Veterinary Research to Human Medicine" by Professor Frei, "Recent Research on Foot and Mouth Disease," and "The Zoological Garden."

Notes and News

The Editor will be glad to receive items of professional interest for inclusion in these columns.

Diary of Events

Sept. 19th.—Meeting of the Editorial Committee, N.V.M.A., at 36, Gordon Square, W.C.1, 4 p.m.

Sept. 20th.—Applications due for Miss Aleen Cust Veterinary Research Scholarship.
R.C.V.S. Examination Committee Special Meeting.

Sept. 30th.—Annual Dinner of R.A.V.C. Old Comrades' Association, at Anderton's Hotel, London, E.C.4, at 7.30 p.m.

Oct. 5th.—R.C.V.S. Committee Meetings.

Oct. 6th.—R.C.V.S. Committee Meetings.

Oct. 7th.—R.C.V.S. Committee and Council Meetings.

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R.C.V.S. OBITUARY

Foulkes, Thomas John, Bromyard, Herefordshire. Graduated Edinburgh, May 23rd, 1893. Died September 2nd, 1938; aged 76 years.

THE GLASGOW CONGRESS

There is no doubt that seaside resorts are ordinarily the most popular venues for conferences of all kinds and when discussion centres round the place at which our future Congresses are to be held the preference for these is plainly shown. It was understandable, therefore, that a small minority of our members expressed feelings of some uncertainty as to the wisdom of this year's choice, particularly in view of recent changes affecting the profession and because of the fact that the International Veterinary Congress had but scarcely closed.

All doubts were quickly dispelled, however, by what seemed to be a record attendance at the "At Home" given by the Scottish Divisions the Sunday evening preceding the opening of the Congress. As President of the Scottish Branch, Major J. G. McGregor, graciously supported by Mrs. McGregor, welcomed the guests to what proved to be a really delightful evening which effectively "broke the ice" for those who were attending their first Congress and enabled "old-timers" to renew friendships made at previous Congresses. The pleasure experienced by all those present was enhanced by songs charmingly rendered by Mrs. John Stewart.

Well over 300 members and visitors were present at the Exhibition to support the President at the first day's proceedings, when members and delegates were welcomed by Bailie Mrs. Jean Mann, Senior Magistrate, and by Sir Cecil M. Weir, Chairman of the Administrative Committee of the Empire Exhibition.

Mrs. Mann, extending greetings on behalf of the Lord Provost, Magistrates and Corporation of Glasgow, referred to the close alliance between the veterinary and medical professions and to the valuable scientific work being performed by both towards the health and welfare of the community.

Sir Cecil Weir said he regarded the Congress as one of the most important held in the Empire Exhibition. That, he remarked, was saying a great deal in view of the fact that before the Exhibition closed at the end of October, between 70 and 80 conferences would have been held within its grounds. He had a personal interest in the Congress because he was in the hide and leather trade. Ever since he entered the business he had been familiar with terms such as foot-and-mouth disease and with the ravages of the warble-fly. He hoped that something really effective would be done to dispose of the warble-fly scourge which was one of the most damaging they knew in the leather trade.

The President, offering the thanks of the Association to Bailie Mrs. Mann and to Sir Cecil Weir, thought it must be a unique event in its history to have the Congress held in a city in which a great Empire Exhibition was

taking place, and more so because the meetings would be within the walls of that exhibition.

The President then proceeded to open the Exhibition of Surgical Instruments and Drugs which, in addition to being larger than in recent years, effectively displayed drugs, instruments and other aids, new and familiar, so essential to veterinary practice in all its branches. A pleasing feature of this part of the proceedings was the presentation by Miss Jeanette Mackie, on behalf of the exhibitors, of a bouquet to Mrs. Campbell.

The social side of the Congress was resumed in the evening when those attending the Congress were the guests of the city at a reception in the City Chambers.

The Lord Provost (Sir John Stewart) welcomed the guests, and after a reply by the President, Captain William Watt (Chairman of the Provisional Committee) also thanked the Corporation for their interest in veterinary work, congratulating the Corporation on being the owner of six herds of over 1,200 cattle—all pedigree Ayrshire, milk recorded and tuberculosis free. He pointed out that the city was among the first of the local authorities to utilise the services of the profession to prevent diseased meat being marketed and in this connection mentioned that J. B. Dunlop, the inventor of the pneumatic tyre, was the first veterinary surgeon in the city to institute legal proceedings in connection with condemned meat.

Bailie Mrs. Jean Mann, who was among other members of the Corporation supporting the Lord Provost at this function, and who had so ably received the Association at the opening meeting, was in the course of the evening presented with a bouquet by Miss Ishbel Campbell on behalf of the N.V.M.A.

A note such as this must necessarily be confined mainly to a survey of the social aspect of the Conference, since reports of the papers and demonstrations will appear in later issues, but it can be said now that these have been voted to be as highly successful as the social functions.

At the time of writing, the Annual General Meeting is in session. Major Brennan DeVine has been enthusiastically elected to succeed Captain Donald Campbell with Mr. H. W. Steele-Bodger as President-Elect.

We are sorry to record that both Captain Wragg and Captain Rider have been compelled by force of circumstances to resign from their respective offices. Mr. H. E. Bywater, well known to our readers as Hon. Secretary of the Central Division, has consented to fill the post of Hon. Treasurer, while Dr. Wooldridge has accepted the Hon. Secretaryship.

It has been decided to hold the 1939 Congress in Great Yarmouth.

FOOT-AND-MOUTH DISEASE

On Friday of last week the Ministry of Agriculture announced the occurrence of an outbreak of foot-and-mouth disease among cattle at Woolhope, Herefordshire. The area restricting the movement of animals covers parts of the counties of Gloucestershire, Herefordsnire, Monmouthshire and Worcestershire.

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ARMY VETERINARY SERVICE

London Gazette—War Office—Regular Army

Sept. 2nd.—Maj. W. St. J. F. Macartney retires on ret. pay (Sept. 3rd).

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Expert opinions on many aspects of poultry farming will be heard at the Fifteenth Annual Poultry Conference at the Midland Agricultural College, Sutton Bonington, Loughborough, on Tuesday, September 13th. Mr. P. A. Francis (Poultry Commissions, Ministry of Agriculture) will preside over the Conference.

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SCIENCE AND GOVERNMENT

There are many points in the following review (which we reproduce from *Nature*, July 16th) of the lecture delivered by Professor J. G. Kerr which will be of considerable interest to our readers who are engaged in veterinary work in the Colonies. No doubt they will wish to consult the original document and we will be glad to receive any views which they would like to express on the subject.

"A lecture entitled 'Science and Government,' recently delivered to the Royal Philosophical Society of Glasgow by Professor J. Graham Kerr, raises questions of the widest concern. Its theme is the utilisation of science in the interests of the community and the inculcation of scientific methods of thought into governance—matters outside the sphere of party politics. Professor Graham Kerr is a believer in democracy and prefers our bureaucratic system to that of totalitarian States; the former is slow in action but flexible, while the latter, though more speedy in action, has a certain rigidity, and its dependence on the ability and principles of the individual renders it liable to a sudden collapse. He compares the bureaucratic machine to an organism. Its increase in size contains its own elements of danger in the development of a longer and longer chain of organisation, which is liable to have weak links and thus to break down under strain.

"It is unquestioned that the organised modern State depends on the successful applications of science, alike to the feeding, motility, health and recreation of the whole population, as well as in securing the safety of the community from foreign aggression. The development and efficiency of services in these matters are the sole concerns of several ministries. The business of their executive officers is, for the most part, the application of regulations in their different spheres, but secondarily they have to advise the ministers responsible to Parliament. As the higher departmental staffs consist of individuals generally chosen for ability by examinations in which science, being unprofitable, is a subordinate subject, ministers can scarcely rely upon their advice in major concerns; if capable of understanding, they have not the time—perchance, the inclination—to keep abreast of the advances of science. Hence the institution of advisory committees, strongly endorsed by

Professor Graham Kerr on account of their 'cold-blooded, judicial consideration' of questions placed before them.

"The personnel of these committees, having been properly selected, must subject the ministers to no 'fussy interference,' while, above all, a ministry must in its turn try neither to persuade nor to bring pressure by raising purely administrative or political difficulties. As a general principle, it is suggested that every administrative ministry, civil and military, should have its own advisory committee, and examples of the success of these committees are given. In all cases where a ministry has its own scientific department, it should help its members to discuss their scientific problems with colleagues whose activities are more concerned with the fundamentals of science. In the modern civilised State, however, all these matters depend ultimately for their success on the general educational system, which is considered by Professor Graham Kerr to demand a thorough overhaul as a matter of national concern.

"Considering the topic 'science and government' more widely, we regret that Professor Graham Kerr did not let his thoughts wander to the Empire. The Dominions have made considerable advances in education by the evolution of new technique and the development of almost new subjects—and in most of their interests they have independent experts upon whom they can call for advice. The Colonies have practically no experts apart from those commercially and personally concerned. Colonies represent earlier stages in the evolution of civilised States and independent democracies than do Dominions. Their environmental conditions are obviously immature. Health is all-important; food has to be produced, perhaps new foods introduced; transport should be easy; luxuries from abroad must be balanced by excess production culminating in exportation; and lastly all questions concern at least two races of man in each colony. Here, as in the home State, success depends on experts, between them capable of applying each branch of science. More often than not these experts are private individuals who risk their wealth in practical business, an excellent arrangement provided that this business is kept duly subordinated to the interests of the colony.

"The executive officers of a colony have to devote their energies to keep the machinery of government smoothly running and to this end have now some training enabling them to consider the inter-relationships of races living together. How far are these individuals, largely chosen for their informative and cultural education, capable of dealing (for example) with food production and, perchance, the reports of specialist officers, if they themselves are ignorant of the basal methods employed in such work? Obviously governors of colonies scarcely belong to the present age, but how many of their executive officers have been trained in the methods of science? What value is placed on such knowledge in their selection? In the probationary period, before proceeding to colonies, what time is devoted to training in the scientific method, if the individual is chosen for other sides of learning? In other words, have the methods in the governance of the Colonies kept pace with the scientific evolution of the last decades? The Colonial Office alone has the information necessary for reply. In democracy, colonies must be held by the consent and goodwill of the governed, and the Empire demands an efficiency of management leading through prosperity to a permanency of union.

"Lastly, from our point of view, the payment and pension problem has long been a matter of concern, the conditions in the scientific services being inferior to those in the administrative. In a statement to Parliament,* the Colonial Office appreciates the necessity of a 'Standardisation of Conditions,' which, since a 'a uniform pension rate has been laid down as suitable for officers of the unified Services,' can only mean a gradual rectification of a grievance of scientific workers. This is a necessary step to secure the best recruits for the scientific services, the training for which is long and intensive and in which only men of high ability are required. The Colonial Office thereby attains a liberty of action which previously it could not exercise. No longer need it transfer an officer who has made an intensive study of the scientific problems of one colony to a post in another, thus promoting him while rendering his study nugatory. If the Colonial Office requires, he can now be called upon without injustice to identify himself with the particular colony in which his success and perhaps affection lie. The old system of promotion, solely by transference, was often unsuited to the scientific services and made permanency in any colony a sign of ineffectiveness."

*The Colonial Empire in 1937-38: Statement to accompany the Estimates for Colonial and Middle Eastern Services, 1938. (Cmd. 5760.) Pp. 79. (London: H.M.S.O.) 1s. 3d. net.

Correspondence

Letters to the Editor should reach the Office not later than by the first post on Tuesday morning for insertion in following Saturday's issue.

All correspondence must bear the name and address of the contributor for publication.

The views expressed in letters addressed to the Editor represent the personal view of the writer only and must not be taken as expressing the opinion or having received the approval of the N.V.M.A.

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SALT IN THE TREATMENT OF CONTAGIOUS NECROSIS IN CAMELS

To the Editor of the Veterinary Record

Sir,—May I use your columns to request anyone who has given camels an increased salt ration in order to cure contagious necrosis to kindly inform me of any results, good or bad, which they have observed.

I am, Sir,
Yours faithfully,
Edward F. Peck,
Chief Veterinary and Agricultural Officer.
Veterinary and Agricultural Department,
Burao,
British Somaliland.
August 10th, 1938.

The Editor acknowledges, with thanks, the receipt of the following: Communications from Mr. John D. Peele (Durham), Lieut.-Colonel E. C. G. Maddock (Reading), and Mr. G. K. Buckler (Stevenage).

Reports of meetings of the Lancashire Division, and North of England Division, N.V.M.A.